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THE COVER

Goya Attended by Doctor Arrieta
by Francisco de Goya

A legend at the bottom of the painting reads, in translation: "Goya, thankful to his friend Arrieta: for the skill and care with which he saved his life during his short and dangerous illness, endured at the end of 1819, at seventy-three years of age. He painted it in 1820."

The artist presented this painting to his doctor, Eugenio García Arrieta, after recovering from a severe illness that has not been identified with certainty. The physician, who is also shown as a caring friend, administers to his very sick patient a beaker of wine that probably contains a stimulating tonic.

Goya's unalloyed gratitude might be contrasted with his earlier satires of pompous learned doctors, as in the 1799 etching of two ass-physicians attending a patient over the title "Of what will he die?"—to which contemporary Spaniards would have replied, "He will die of the doctor." The image is from the collection of the Minneapolis Institute of Arts.

The painting is oil on canvas, 116 by 79 cm.

Introduction

Changing Fashions in Therapeutics

The systematic study of medical therapeutics almost seems to have been avoided—perhaps unconsciously—by the majority of medical historians, even by those who are medically trained. While changes in surgery and psychiatry, and in medical diagnosis, have often been documented, the evolution of therapeutic methods (e.g., drugs, diet, bleeding, and blistering) has been examined only infrequently. Even then, the study has usually been indirect, focussing primarily on theoretical considerations rather than on firsthand evidence of what physicians actually prescribed for their patients. The reasons for historians' apparent neglect of physicians' remedies are complex.

The word "protopharmacology" was coined by an eminent pharmacologist who was also a historian of medicine to characterize the clinical use of drugs before pharmacology emerged as a separate biomedical discipline after 1849, when Rudolf Bucheim established the first academic laboratory for the study of drug effects at the University of Dorpat, Estonia.[1]

For the previous twenty-five centuries, physicians had classified drugs by their obvious effects on the human body—as, for instance, emetics, cathartics, diuretics, diaphoretics, stimulants, emmenagogues, and so on. (Several new drug classes, such as antispasmodics and tonics, appeared as by-products of the newly emerging solidist concept of disease by about 1700, but their sedative and stimulating effects, respectively, were more speculative than real.)

During the centuries between Hippocrates and Bucheim, doctors added drugs to their therapeutic arsenals chiefly on theoretical grounds; they assessed each drug's clinical efficacy by observing whether its administration was followed by the patient's recovery. That method has sometimes been called empiric, a word that was often accurately descriptive but at other times was applied pejoratively to a confusing variety of practitioners—from charlatans to those who were self taught, albeit in the prevailing, academically approved, theories.

by J. Worth Estes, Guest Editor

Most historical remedies now seem bizarre, lacking any recognizably "scientific" rationale for their utilization. For example, how could anyone in his right mind have believed that an emetic or cathartic—much less bleeding or blistering—could cure a disease now known to be of infectious origin, much less a heart disease? Moreover, the huge number of drugs that were in regular use before 1850—nearly fourteen hundred, equally divided among simples and complex mixtures—could only aggravate the sense of overwhelming confusion a modern historian might feel about them, especially today when the apparent general rule is one diagnosis, one drug.

In short, like the rest of us, historians may be reluctant to study, much less write about, phenomena they feel they cannot comprehend. Only a few writers have elucidated the logic behind the emergence or persistence of theoretical approaches to nonsurgical illness,[2] or have explored the detailed histories of individual drugs in terms of their effects on patients.[3] Nevertheless, drugs are, and always have been, a physician's stock in trade, and the prescription is still the end product of most doctor-patient encounters, which itself suggests that the history of clinical remedies deserves more attention than it has received.

One might argue that another major contributor to historians' difficulties in dealing with drug therapies of the past is the nature of the materials they customarily use to document their observations, chiefly monographs (whether in manuscript or printed form) and journal articles, depending on the time frame of their study. Such sources, however, provide no clues to any drug's acceptability within the medical profession in terms of the numbers of practitioners who actually prescribed it, although prescription frequencies are at the heart of modern assessments of drug usage by both the federal government and the pharmaceutical industry. Sometimes medical authors did outline the reasoning behind their therapeutic choices, but more often they seem to have assumed that their readers were already sufficiently familiar with such reasoning that it need not be repeated. What all those historical texts have in common is their authors' claims, or suppositions, that the remedies they describe are effective in the treatment of human illness—otherwise they probably would not have written about the drugs in the first place. Indeed, negative reports of drug efficacy are uncommon even in the late twentieth century.

Historians have seldom asked questions about the *efficacy* of historical treatments. Indeed, some scholars have come to conclusions about efficacy drawn from premises as fallacious as those used by physicians in the past (although it is true that the quantifiable data needed by historians in order to make valid inferences about efficacy are rare in the pre-twentieth-century record). In fact, medical historians seem to have preferred to seek answers to questions about the doctor-patient relationship and the socioeconomic circumstances that influence it rather than about the therapy itself.

Inasmuch as most historical drugs in the protopharmacological past *could* not have had any truly beneficial

therapeutic effect (save in a very few instances), one can only wonder why patients continued to patronize their physicians during all those centuries. And why did patients continue to pay for what can now be recognized as ineffective remedies?

The answers to such questions begin to emerge once one recognizes that patients would not have continued to seek doctors' help unless they were satisfied with the results they obtained. Convincing confirmation of that hypothesis requires that we ascertain the actual outcomes of individual treatments or treatment regimens, outcomes that cannot reliably be inferred solely from a few textbooks or single "case reports" of the past. It would not be appropriate or realistic to postulate something like a mass placebo effect to account for the widespread satisfaction with medical treatment over many centuries. Besides, the word *placebo*, which assumed its modern definition only in the early nineteenth century, implies that the prescribing physician knows that such a drug is physiologically inert; that was certainly not the case for protopharmacological remedies. Along the same lines, there is no evidence, despite popular suppositions, that strongly positive psychological bonds between doctor and patient have ever contributed significantly to medical recovery *per se*, although they may have other welcome aspects in the sickroom. Only in the 1940s did the medical profession begin to use negatively-controlled and double-blinded clinical trials to assess the therapeutic efficacy of drugs on a regular basis.[4] The technique was mandated in the United States in 1962, made necessary in the wake of development of remedies for newly important illnesses, such as as hypertension and anxiety, that lacked simple etiological definitions.

Several kinds of alternative sources suitable for use by historians interested in the therapeutic practices of the past have not been fully exploited: patients' diaries and physicians' manuscript records of what they did for whom. Such records are valuable because they often reveal not only what the average physician did for his patients but perhaps why, which may or may not have been what the cadre of learned, academic physicians proclaimed in their lectures or textbooks.

Many firsthand accounts of historical medical practices are found in family records and diaries, physicians' daybooks and account books, letters written by distant consultants, apothecaries' records, or, most systematically of all, official records designed to help governments predict military medical needs in wartime.[5] Even when such documents, each of which has its own inherent limitations, permit analyses no more complicated than counting the frequencies with which doctors prescribed the drugs in their repertoires, those counts alone can furnish valuable insights into routine daily practices, revealing differences among individual doctors' favorite remedies or among the drugs prescribed by doctors who practiced in different places and circumstances. In any event, the raw data found in such documents were not collected in the first instance in order to determine drug efficacy, or even to compare drugs, although they might,

on rare occasions, be used retrospectively for just such purposes.

Eighteenth-century students at the Royal Infirmary in Edinburgh wrote detailed clinical observations each day while making ward rounds; they recorded pertinent comments and the therapeutic recommendations of attending professors.[6] Students' notes furnish an extraordinarily valuable resource because they often outline the rationales for each prescription, especially when professors were treating the evolving complications of primary illnesses. In addition, the collated notes provide unusual opportunities for retrospective quantitative studies when they record patients' pulse rates or other quantifiable information such as fluid intake and output. Further inferences about the clinical uses of therapies and drugs favored by hospital physicians can be drawn from the internal administrative records kept by hospitals.[7] (The modern hospital record, designed in the first instance to record treatments and their outcomes as a professional self-improvement tool, was invented only after the First World War.)

The exploitation of such primary source materials has recently begun to fuel more detailed studies of historical treatments than had previously been customary. It has revealed two phenomena that can now be understood within the context of the day-to-day practices of doctors of almost any time and place in the western European medical tradition: First, that doctors *did* rely on the same range of treatments over the centuries between Hippocrates and 1849 (although with some important qualifications—such as the introduction of chemical remedies during the early sixteenth century and the declining reliance on polypharmaceutical mixtures in the eighteenth century); and second, that what changed most was doctors' perceptions of *why* their remedies were effective.

Study of what might loosely be called patient records—whether as account books, military surgeons' records, hospital or apothecary records, or medical students' notes—helps us understand the widespread acceptance of the efficacy of the hundreds of drugs that had become available by the late eighteenth century: such documents reveal that recovery rates ranged up to about 95 percent among adult patients in the absence of serious epidemic diseases such as small pox and yellow fever (however, cure rates could be as low as 65–70 percent among hospitalized patients, and even lower among patients with structural disorders of the heart).[8] Keep in mind that although many drugs did produce vomiting, catharsis, or sweating, for example, neither those effects nor the drugs themselves could have significantly altered the course of most illnesses.

If, under most circumstances, only about five percent of adults failed to respond favorably to their doctors' remedies, we can begin to understand patients' satisfaction with the treatments they received from their physicians, as well as their expectations of successful outcomes, few of which could have resulted directly from the pharmacological properties of drugs prescribed before the twentieth century. Instead, the combined

records testify to the successful operation of the *vis medicatrix naturae,* the healing power of nature, made possible by the body's ability to heal itself with the immune, phagocytic, and tissue repair mechanisms, at least when dietary intake permits.[9] The same mechanisms can also explain the apparent efficacy of most so-called "alternative healing systems," including those of rain forest shamans, even today. Similarly, the fact that only about five percent of conceptions come to full term in the normal course of events, even in the absence of consciously applied attempts to interfere with pregnancy, may explain at least a portion of women's satisfaction with the results of historical contraceptive measures from the plant kingdom.[10]

The essays in this issue of *Caduceus* illustrate several changes in therapeutic practices in "snapshots" made at four points over the past seven centuries—in, roughly, the 1290s, 1690s, 1790s, and ending in the 1890s. Michael McVaugh and Luís García Ballester present the arguments used by a late-thirteenth-century physician when treating patients within the ancient tradition of Galenic humoralism. Their translation of a medieval medical school lecture highlights the complexity of therapeutic thinking for even a single patient, permitting us to see that treatment was not fixed according to scholastic rules but was continually adjusted as patients' symptoms evolved.

Seventeenth-century documents help Norman Gevitz and Micaela Sullivan-Fowler illustrate clinical practice in Plymouth Colony. By this time, chemical remedies in the Paracelsian tradition were being prescribed along with those in the Galenic botanic tradition in everyday regular medicine: both kinds of medicines had been judged to be equally efficacious.

Next, Frederic L. Holmes traces the influence of the laboratory experiments performed by Lavoisier and others on how doctors thought about diet and specific chemical remedies. One of the ironies of the history of therapeutics is that Lavoisier unseated the phlogiston theory from textbooks of chemistry and medical dietetics but not from everyday therapeutic practice, where depletive—i.e., antiphlogistic—treatments such as bleeding remained among the cures for febrile illnesses.

Finally, Christopher Crenner shows how the newly emerging discipline of anatomic pathology began to influence doctors' choices of remedies for their patients. This was perhaps the greatest intellectual leap among the steps between the time-honored theorizing of the past toward today's focus on receptors as sites of drug action. Thus, changes in therapeutic fashion before the late nineteenth century reflect chiefly the evolution of physicians' views of how their patients' illnesses were triggered, and of how they affected the putative balances among the body's humors, irritable fibers, or acids and alkalis, during all the centuries before diseases were described and defined, not in terms of speculative pathophysiology but in terms of anatomic lesions visible to those who looked.

Among the most frequently prescribed drugs in the Galenic tradition, emetics have always caused vomiting by

stimulating serotonin or dopamine receptors in the intestines or the central nervous system, and cathartics have always produced stools by stimulating intestinal motility or by retaining water within the gut lumen. But neither emetics nor cathartics have ever been able to selectively eliminate contagions from the lungs or anywhere else, even if doctors routinely prescribed them for just that purpose during the long reign of protopharmacological thinking. Similarly, because cinchona (or Peruvian bark) was found to be almost universally effective in the treatment of intermittent fevers (i.e., malaria) during the later seventeenth century, physicians reasoned that it should be equally effective in the treatment of all other fevers (i.e., the continued fevers). Moreover, because it was bitter and astringent, it easily fell into the new class of stimulating tonic drugs by the end of the century. Inasmuch as recovery from the debilitating convalescence associated with many fevers usually followed a course of treatment with cinchona, it became another mainstay of fever therapy. Thus, by the early eighteenth century, standard treatment for serious febrile illnesses began with emetics on the first day, followed by cathartics on the second or third days, and by cinchona, often for many days, once the patient's symptoms had begun to wane. There was no good reason not to give those drugs the credit for his cure. They were among the triumphs of therapeutic practice in the *post hoc, ergo propter hoc* mode.

Writing at about the time Lavoisier's discoveries were entering mainstream medical thought, the French physician Marie-François-Xavier Bichat saw that:

> The same drugs were successively used by humoralists and solidists. Theories changed, but the drugs remained the same. They were applied and acted in the same way, which proves that their action is independent of the opinion of doctors.[11]

An 1807 letter written by Bichat's older contemporary Thomas Jefferson to Dr. Caspar Wistar of Philadelphia sums up the issue of changing therapeutic fashions—although the President, like a number of historians of medicine, was more caustic than we have been:

> [T]he adventurous physician goes on, and substitutes presumption for knowledge. . . . He establishes for his guide some fanciful theory of corpuscular attraction, of chemical agency, of mechanical powers, of stimuli, of irritability accumulated or exhausted, of depletion by the lancet and repletion by mercury, or some other ingenious dream, which lets him into all nature's secrets at short hand. [He] extends his curative treatment, by analogy, to all the cases he has thus arbitrarily marshalled together. I have lived myself to see the disciples of Hoffman[n], Boerhaave, Stahl, Cullen, Brown, succeed one another like the shifting figures of a magic lantern. . . . The patient, treated on the fashionable theory, sometimes gets well in spite of the medicine. The medicine therefore restored him.[12]

Despite his sarcastic view of the medical theorizing of his day, Jefferson had faith in the promise of what the competent physician could do for his patient.

As the papers in this issue of *Caduceus* show, so has everyone else in the past.

■

Notes

1. Chauncey D. Leake, *An Historical Account of Pharmacology to the Twentieth Century* (Springfield, Ill.: Charles C Thomas, 1975), 17.

2. See, e.g., Lester S. King, *The Medical World of the Eighteenth Century* (Chicago: University of Chicago Press, 1958); Charles E. Rosenberg, "The Therapeutic Revolution: Medicine, Meaning, and Social Change in Nineteenth-Century America," *Perspectives in Biology and Medicine* 20 (1977): 485–506; Guenter B. Risse, "'Typhus' Fever in Eighteenth-Century Hospitals: New Approaches to Medical Treatment," *Bulletin of the History of Medicine* 59 (1985): 176–95; John Harley Warner, *The Therapeutic Perspective: Medical Practice, Knowledge, and Identity in America, 1820–1885* (Cambridge, Mass.: Harvard University Press, 1986); Samuel B. Thielman, "Madness and Medicine: Trends in American Medical Therapeutics for Insanity, 1820–1860," *Bulletin of the History of Medicine* 61 (1987): 25–46; J. Worth Estes, "The Road to Tranquility: The Search for Selective Anti-Anxiety Agents," *Synapse* 21 (1995):10–20; and J. Worth Estes, "The Yellow Fever Syndrome and Its Treatment in Philadelphia, 1793," in "*A Melancholy Scene of Devastation*": *The Public Response to the 1793 Philadelphia Yellow Fever Epidemic*, ed. J. Worth Estes and Billy G. Smith (Canton, Mass.: Science History Publications, in press for 1996).

3. See, e.g., Judith P. Swazey, *Chlorpromazine in Psychiatry: A Study of Therapeutic Innovation* (Cambridge, Mass.: MIT Press, 1974); J. Worth Estes, *Hall Jackson and the Purple Foxglove: Medical Practice and Research in Revolutionary America, 1760–1820* (Hanover, N.H.: University Press of New England, 1979), chaps. 3–6; and Saul Jarcho, *Quinine's Predecessor: Francesco Torti and the Early History of Cinchona* (Baltimore: Johns Hopkins University Press, 1993).

4. Abraham Lilienfeld, "*Ceteris Paribus*: The Evolution of the Clinical Trial," *Bulletin of the History of Medicine* 56 (1982): 1–18; J. Worth Estes, "Quantitative Observations of Fever and Its Treatment Before the Advent of Short Clinical Thermometers," *Medical History* 35 (1991): 189–216, n. 110.

5. For family records and diaries, see the following essays from *Medicine and Healing*, ed. Peter Benes, vol. 15 of Annual Proceedings of the Dublin Seminar for New England Folklife (Boston: Boston University, 1992): Barbara McLean Ward, "Medicine and Disease in the Diary of Benjamin Walker, Shopkeeper of Boston," 44–54; Wanda Burch, "Sir William Johnson and Eighteenth-Century Medicine in New York Colony," 55–65; and Robert I. Goler, "A Household and Its Doctor: A Case Study of Medical Account Books in Colonial America," 66–81.

For physicians' daybooks and account books, see, e.g., J. Worth Estes, "Therapeutic Practice in Colonial New England," in *Medicine in Colonial Massachusetts, 1620–1820*, ed. Philip Cash, Eric H. Christianson, and J. Worth Estes (Boston: Colonial Society of Massachusetts, 1980), 289–383; Paul Berman, "The Practice of Obstetrics in Rural America, 1800–1860," *Journal of the History of Medicine and Allied Sciences* 50 (1995): 175–93; and Amalie M. Kass, "'Called to Her at Three O'Clock AM': Obstetrical Practice in Physician Case Notes," *Journal of the History*

of Medicine and Allied Sciences 50 (1995): 194–229.

For correspondence by distant consultants, see, e.g., Nancy G. Siraisi, *Taddeo Alderotti and His Pupils: Two Generations of Italian Medical Learning* (Princeton: Princeton University Press, 1981); *The Clinical Consultations of Giambattista Morgagni,* trans. Saul Jarcho (Boston: Francis A. Countway Library of Medicine, 1984); and *Clinical Consultations and Letters by Ippolito Francesco Albertini, Francesco Torti, and Other Physicians,* trans. Saul Jarcho (Boston: Francis A. Countway Library of Medicine, 1989).

For apothecary records, see, e.g., David L. Cowen, Louis D. King, and Nicholas G. Lordi, "Nineteenth Century Drug Therapy: Computer Analysis of the 1854 Prescription File of a Burlington Pharmacy," *Journal of the Medical School of New Jersey* 78 (1981): 758–61; David L. Cowen, "The Impact of the Materia Medica of the North American Indians on Professional Practice," in *Botanical Drugs of the Americas in the Old and New Worlds,* ed. Wolfgang Hagen Hein (Stuttgart: Wissenschaftliche Verlagsgesellschaft, 1984), 51–63; and Michael R. McVaugh, *Medicine Before the Plague: Practitioners and Their Patients in the Crown of Aragon, 1285–1345* (Cambridge, Eng.: Cambridge University Press, 1993), 150–58.

For official wartime records, see, e.g., J. Worth Estes, "Naval Medicine in the Age of Sail: The Voyage of the *New York,* 1802–1803," *Bulletin of the History of Medicine* 56 (1982): 238–53.

6. J. Worth Estes, "Drug Usage at the Infirmary: The Example of Dr. Andrew Duncan, Sr.," App. D in Guenter B. Risse, *Hospital Life in Enlightenment Scotland: Care and Teaching at the Royal Infirmary of Edinburgh* (New York: Cambridge University Press, 1986), 351–84, 434–35; J. Worth Estes, "Quantitative Observations."

7. Risse, *Hospital Life*; Warner, *Therapeutic Perspective.*

8. J. Worth Estes, "Making Therapeutic Decisions with Protopharmacologic Evidence," *Transactions & Studies of the College of Physicians of Philadelphia,* n.s., 1 (1979): 116–37; Estes, "Naval Medicine"; Estes, "Drug Usage."

9. For a rare example of how raw data that have little to do with drugs *per se* can lead to similar and equally valid conclusions about patients' satisfaction with and expectations of physicians, see McVaugh, *Medicine Before the Plague,* passim.

10. John M. Riddle, J. Worth Estes, and Josiah O. Russell, "Ever Since Eve: Birth Control in the Ancient World," *Archaeology* 47 (1994): 29–35.

11. Quoted in Erwin H. Ackerknecht, *Medicine at the Paris Hospital, 1794–1848* (Baltimore: Johns Hopkins University Press, 1967), 131.

12. Saul K. Padover, ed., *The Complete Jefferson* (New York: Tudor Publishing Co., 1943), 1060–62.

J. Worth Estes earned an M.A. in Pharmacology and an M.D. at Boston University School of Medicine, where he is a Professor of Pharmacology. His research specialty is the therapeutic practices of the eighteenth and nineteenth centuries. The author or co-editor of many works on various aspects of the history of medicine, including six books, his most recent was the *Dictionary of Protopharmacology: Therapeutic Practices, 1700–1850* (Science History Publications, 1990). Now working toward a general history of pharmacology, he is also the current Secretary-Treasurer of the American Association for the History of Medicine.

Therapeutic Method in the Later Middle Ages: Arnau de Vilanova on Medical Contingency

Historians of medicine often dismiss the medieval academic physician as a mere "scholastic," someone chained to his books whose slavish devotion to authorities like Galen and Avicenna precludes imagining him as an effective practitioner. They have found it easy to assume that his presumed narrow focus on rigid categories and definitions made it impossible for him to be a sensitive clinician. To some extent this is because most texts that survive from the medieval university show the physician as a lecturer, expounding authoritative books to his students; it is not generally appreciated that the academic physician was also deeply concerned about clinical experience and tried to give his students a sense of what it required of them as they proceeded from diagnosis to treatment.

The following passage is extracted from a *repetitio* (a student's transcription of a teacher's lecture, usually checked for accuracy by the teacher himself) on the first of Hippocrates' *Aphorisms* ("*Vita brevis, ars vero longa*") as taught by Arnau de Vilanova, perhaps the most famous physician in Europe about 1300 A.D.; the lecture would have been delivered to medical students at Montpellier in the 1290s. Arnau regularly quotes here from Galen, and his examples are couched in the language of late-medieval medical theory, yet even so the selection should help correct historians' dismissive attitude towards the supposedly doctrinaire scholastic physician, for it shows us a teacher trying to wean his students from a dependence upon fixed rules as they treat their patients, trying to impress on them the particularity of medical experience.

Arnau does indeed begin by reviewing two of the lists that provided medicine with its basic structure and that every medical student learned early in his education: the three divisions of therapeutics—diet (or, more generally, regimen), drugs, and manual operation or surgery—and the six non-naturals into which regimen/diet was subdivided.[1] To these he adds one further list that is less familiar, comprising the four aspects of dietary or medicinal treatment: what you give the patient, in what

by Michael R. McVaugh and Luís García Ballester

strength, in what form, and in what sequence. But he goes on almost immediately to emphasize that within the last four categories the practitioner cannot mechanically follow a single standard approach; there are limits, one might say, to the logical structure of therapeutics. Even though patients may be disconcerted when the physician alters a course of treatment, the physician himself must always be aware that the progress of the illness is inherently likely to force changes in how he treats it, and that the very remedies he uses may have side effects that will require him to introduce new drugs into his procedure.

Beyond those reasons for changes in treatment that are inherent in the particular case, Arnau goes on, the physician must be alert for extraneous factors, contingencies (*accidentia*), that can overturn all his expectations and plans—not only external circumstances that may be foreseen and so avoided (by moving a patient out of a potentially drafty room, for example) but also those that can be detected only after the fact, when something totally unexpected has occurred. In this latter case, Arnau suggests, the physician will have need of all the inductive skill he can marshal in order to identify the extraneous factor that has interfered with his treatment so that he can then counteract or eliminate it.[2]

Arnau's discussion of medical contingency is even more remarkable because it is illustrated with a series of brief yet relatively circumstantial case histories, accounts of a kind all too rare in medieval medical literature; they are meant to bring home more vividly to students how many things that are not logically part of their therapies can affect a patient's health and must constantly be borne in mind. Such vignettes convey to us a little of what medical practice must have been like in the later Middle Ages. We need not accept the diagnoses or pathological system implicit in the cases, we need not even believe that the patients ever existed, to recognize here a physician's sensitivity to the individual and to his circumstances that transcends all rigid theoretical formulations—as well as a silent warning that no practitioner can afford to be overconfident in his own powers, and that second opinions can sometimes be valuable.

As can perhaps be imagined, the full *repetitio* from which the following extract has been drawn is even more fascinating, for it is a text virtually unique in permitting us to extend and develop a detailed understanding of the medieval physician's concerns as he pursued his daily round. Over and over, the *repetitio* emphasizes what is apparent in our little excerpt—the physician's need to attend to the individuality of each patient, to observe the little details that shape the patient's life, and to identify the particular symptoms that will allow the physician to announce a prognosis and formulate a treatment. Arnau's *repetitio* portrays, intelligently and realistically, a medical art whose mastery requires time, intellectual and physical effort, and experience. For Arnau de Vilanova, after all, the purpose of the commentary was to bring his disciples to appreciate the meaning of the adage "*Vita brevis, ars vero longa*," and his own thirty years in medicine made it easy for him to talk feelingly about its

truth. No doubt, scholastic medical training ensured that students learned, first of all, from books, many of them Galen's; but the other side of that coin was that those students' reading steeped them, through Galen but also directly, in the thought of the man whose faithful interpreter Galen always proclaimed himself to be: Hippocrates.

The translation provided here is based on the Latin test we are preparing for a future volume of the *Opera Medica Omnia Arnaldi de Villanova*, a volume whose publication is expected in 1996. We have tended towards presenting a literal rather than a free translation into English, and our text inevitably reads a little awkwardly. But at least our practice has the merit of not anachronistically modernizing Arnau's pathological and physiological terminology: we have retained, for example, his language for different types of fevers—ephemeral, quotidian, hectic—without trying to relate them to diseases like typhoid or malaria or tuberculosis with which they might be associated today. Given the imminent availability of the Latin original, we have not thought it necessary to include it here, especially since a corrupt but still generally intelligible Latin text is included in the incomplete version of Arnau's *Repetitio Super Canonem "Vita Brevis"* published in the various sixteenth-century editions of his collected works.[3]

AN EXCERPT FROM

Repetitio Super Canonem "Vita Brevis"

by Arnau de Vilanova

In drawing up a therapeutic regimen the physician should follow a certain order with regard to the particular therapies that comprise what it means to make up the work of cure. These are three, as Galen says in the prologue to the *Regimen Acutorum:* diet, administration of drugs, and surgery. The first of these is the basis and foundation of the other two, for two reasons: first, that diet above all is directed to the target of the entire art [of medicine], the reason why it is practiced—namely, the maintenance of the power by which a person lives and makes health necessary; and second, that the other two therapies cannot be successful without diet, but diet can succeed without them, so that in a way it is their cause or foundation. Administering drugs should precede surgery because it concerns illnesses generally, while surgery [does so] only in part; for the giving of medicines is appropriate to all illnesses of whatever genus and species, surgery only to certain particular illnesses, and moreover only to those that are obvious externally.

Regarding the arrangement of diet—that is, the adjustment of all the things that the healthy individual requires (i.e., air and clothing, motion and quiet, food and drink, sleep and waking, evacuation and retention of daily wastes, emotions)—the physician should follow this sequence.

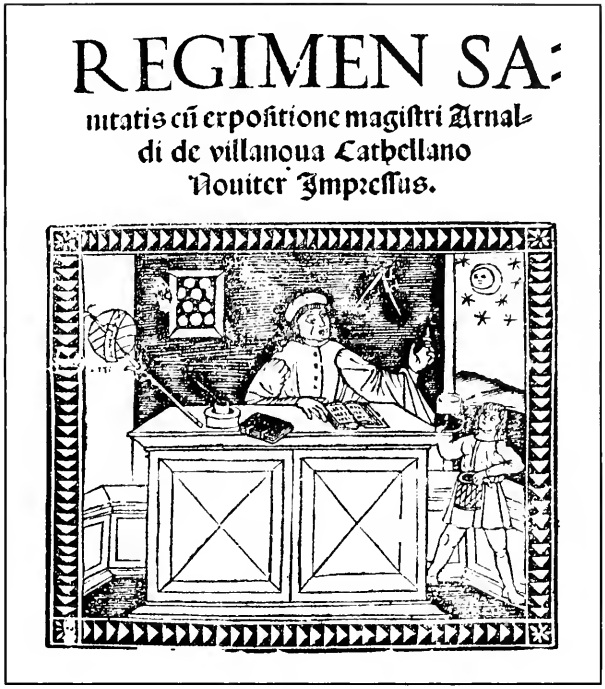
First, he should decide whether the air of the house or place is good for the patient, and if not, he should decide how it might be improved. Likewise concerning clothing and bedlinen, [he should decide] what is appropriate, whether it is better [for the patient] to lie with more or fewer bedclothes, or with his head more covered or less, and likewise his feet. He should command attendants to carry out the things that he sees must be done, and command the patient that he obey them in these respects. Then after this he should give orders concerning motion and rest, and the others.

Now the physician's role regarding a course of treatment is like a sailor's, because both govern what is committed to them not by following necessary and permanent rules but by weighing contingent and variable factors. For the sailor has to alter the sails and other things as the winds change; the physician has to modify his tools and practices in accordance with the changes and variations in the illness as well as in the dispositions of the air and the other circumstances by which the body is affected. And thus because it is his responsibility to modify his procedures [when necessary], he must always keep in mind when instructing the attendants and patient that the aims of medical practice will not automatically be reached at some definite time but will depend entirely on the knowledge or judgment of the person in charge, namely the physician himself; and therefore he should tell them, you must follow such-and-such a course of action until the evidence convinces me that it has to be changed. Thus the physician will preserve his authority and will keep the patient and the others from wondering or worrying when he changes his approach—especially since he cannot avoid changing his approach if the art demands it, whether as regards what he gives or its strength or its preparation or the order in which he gives it.

The reason why an adjustment might have to be made in one of these four areas is twofold: one is necessary and inevitable, the other is contingent. The first has to do with the evolution of the illness, for every illness from which someone recovers passes from onset [*principium*], through intensification [*augmentum*], to stasis [*status*], to recovery [*declinatio*]. Thus a dietary regimen will have to change in each of these four stages, as is fully plain in the first part of the *Aphorisms* and in the *Regimen,* not just in one of these four but in all of them. For someone who is given barley in onset should have only almond milk in intensification; or it should be given thick and unstrained at first, then strained. In stasis he should be given chickpea or barley water; in recovery, first chicken broth, then subtle and then grosser flesh little by little until he can go back to a normal diet. Likewise a patient who is given a strained, squeezed tisane to drink during onset should be given it strained but not squeezed in intensification; in stasis he should be given just sugared water; in recovery weak wine at the beginning, then stronger little by little until [he is] normal. In the same way it is necessary to alter the quantity of food and drink in these stages, for in onset a patient may eat more copiously, in intensification less, in stasis least,

while in recovery the sequence is changed so that the regimen begins with a small quantity and is gradually increased up to the maximum, i.e., the normal, over as long a time as the first three stages, as best the physician can judge (or, if it fails to equal it exactly, is at least close). For these two phases of the illness are linearly equal either *in se* or in their symptoms; as Galen proves in *On the Times of Illnesses* and Isaac Judaeus [shows] in *On the Elements*, there is as long a period of time from the final terminus of stasis till the end of recovery as there is from the beginning of the illness to the end of stasis. And this calculation not only helps the patient, it keeps the physician from confusion, because by this estimate the physician can tell the patient, roughly, how long he will have to be obedient to his commands, saying, "You will need at least *so* much time to recover completely; so obey me for that period and I will take care of your case." So too the physician will vary the quality of the food and drink [he prescribes] during these stages, for both should be physically hotter in onset and intensification than in stasis and recovery; and these stages likewise force him to alter the hour of meals, for in onset and recovery he ordinarily will recommend for this the [patient's] accustomed hour of mealtimes when healthy, as modified however by other circumstances, just as these stages required him to alter the regimen of food and drink.

The same thing exactly is true of medicines, both as to the medicines themselves and as to their strength, and because teaching about practice is vague and useless unless it is brought down to particulars, let us give some brief examples of these things. First as to the medicines themselves. If someone with scabies is given a syrup or decoction of



Title page of* Regimen sanitatis [Salernitanum] *with commentary by Arnau de Villanova (Venice: Bernardinus de Vitalibus, 1500?). The learned physician at his desk is about to examine the container of urine that an assistant is removing from a basket in which it has been carried from an absent patient's bedside. (Courtesy of the Boston Medical Library)

borage and fumitory during the onset, in stasis and recovery the fumitory must be changed to wormwood. For in the first stages the patient needs digestion of the scorched humor, while in the later stages [he needs] opening of the pores for its full expulsion. If therefore in these [first] stages something is given that corrects the sharpness and dryness of the scorched humor, like borage, which also protects the heart and spirits from its poison, and again if something is given that thins out the thickness [of the humor] and as it were scrapes it from the surface of the member and opens the pores of the body, like fumitory, this is obviously a sensible procedure—so long as nothing contraindicated occurs, like fear of abortion in women. But once the matter has been digested, during stasis and recovery, the patient cannot escape harm if he continues to use fumitory, for the expulsion of the peccant humor will be prevented and it is sometimes corrupted, and the damage is marked when [the humor] is excessive.

The reason for this is, as Galen shows in speaking about abrotanum and wormwood, that a natural and proper expulsion of matter can be achieved only by pressure, a movement that is brought about by the spontaneous constriction of the pores or cavities within and the dilation of those without. Thus the urine that is in the bladder (as Galen says in *On the Affected Parts* I and more fully in *On the Natural Faculties* II) is never naturally expelled unless the bladder is constricted at its base and the anterior opening is dilated; and the same thing happens [in the expulsion of] intestinal feces and also of the humoral residues that are contained in veins and other cavities or hollows of the body. Conversely, therefore, whatever prevents the moderate pressure or constriction of a pore or member will impede natural expulsion. Now this includes anything bitter and sharp, like fumitory, abrotanum, and the like. (For although fumitory and abrotanum have stypticity, it is small and almost imperceptible when compared to that of wormwood—though it is greater and stronger in fumitory than in abrotanum—and thus in this sense [wormwood's] use is less harmful). Such things unceasingly open the pores and dilate and help dilation, and consequently the matter [i.e., the humors] continues to be diffused through the [body's] cavities, which can lead to two problems: first, when the matter rushes about madly, generating inflammations and passions of the joints; second, when these humors become corrupted, as they are both by the damage remaining and by the use of an unnecessary medicine. For the body that no longer needs fumitory no longer controls that drug's action as it once did; and therefore, diffused like the humors, [the fumitory] will corrupt and so exacerbate the scabies, as many have observed. This is why, in stasis and recovery, the body needs a medicine to help constrict the body's cavities moderately but without preventing them from opening, and one that cleanses the surface of the cavities—that is, a bitter and very styptic or slightly astringent medicine like wormwood. So our patient with scabies will quickly be cured if, once signs appear of manifest digestion [of the humors], he gives up

the use of fumitory and begins to use a decoction of wormwood with wine or whey or other things, as may be tolerated. And this example suffices concerning changes in the medicines themselves.

The situation concerning change of [medicinal] strength can be understood if we consider phlegmatic fevers. In such fevers, we administer a more vinegary syrup in onset and intensification than in stasis and recovery, for when the material is more viscous, it needs something more incisive. In stasis and recovery the viscosity is markedly reduced, though it cannot be carried away entirely because it is inherent in the phlegmatic state; and when its viscosity has been greatly diminished it adheres [only] weakly to the surface of the member, nor does it make as thick a film on the surface as before, and therefore a vinegar drink can reach the substance of the member more quickly than before. Hence a strong vinegariness will now harm the members sensibly when before it did not affect them.

This is why the physician should be careful that his procedures do not prevent him from altering the strength of what he gives, increasing or decreasing it, whenever that should be necessary; errors frequently arise when this is forgotten. For it has happened that someone who is given the same vinegary medicine to drink all the way through to the end of stasis, without any diminution of its strength, finds once he has been freed from the fever that he is constantly panting, with the tissues of his breast constricted.

There were once two physicians on the case of just such a patient, and once they had considered all the factors the elder said to the other: "I recommend that the vinegar be added to the syrup not now but each time that it is prepared, when the patient needs to drink it, and in this way we can keep taking into account the strength of the patient." It happened that the one who said this had to leave briefly. The one who remained took over the treatment but scorned to follow the advice of his colleague; but then, when the patient reached stasis, he began to suffer terribly from sciatica and gout. At this point the senior physician returned, and when he found the patient worse he asked about the regimen he had been following and discovered that he had been drinking a syrup of uniform and strong vinegariness. Then he asked the patient whether he had ever suffered other pains in those joints; he replied, "No, except once when I had to go barefoot in winter in a river for a long time, and after that my legs felt heavy but not very painful." And so the physician recognized that the evil of a cold complexion had weakened those parts and sensitized them to the action of the vinegar. It should thus be plain how the [four] stages of illness force us to change the kinds and strengths of the medicines we prescribe; it should also be obvious that the same thing will be true of their quality, just as was explained in the case of food and drink. As for the time of their administration, [the four stages] affect it only slightly—unless the unexpected occurs, for if for example the patient should be attacked by vomiting or precordial

pain at the moment when we had intended to administer a medicine, the time will have to be changed. But we will come back to the unexpected soon.

Let us return to the second reason why a physician may need to alter his procedures, contingent rather than necessary factors. Again, the physician should know that they can require him to make changes to diet or medication in one of the four aforesaid ways. The contingencies that can arise (especially from external factors) are unforeseeable and innumerable, and more will be said about them below. But of all these factors, the physician must first of all keep in mind those that arise from his own treatment: for example, he may give a vinegary syrup to a patient with ephemeral or quotidian fever, and if he administers it for a long period he may hope—or better fear—that the liver will be chilled and the perfect digestion of blood be thereby impeded. So fear of this contingency over the course of time ought to induce him not only to decrease the strength of the vinegar but to give something else that will reinforce the liver, and this is why all the wisest [physicians] advise that in such a case the patient should be given troches of eupatorium or the like every fourth and then every third [day]. Likewise it is plain *per se* how the contingencies that arise can force us to alter the strength or the quality of the medicine that we prescribe and even the moment when we administer it, and the same thing is true of the sequence in which we administer a series of medicines.

I give an example for students. It happened that a physician was treating a patient who had taken opium or henbane and was constipated by nature. So the physician sensibly commanded that at the beginning of the meal the patient should eat figs with nuts and at the end a dried pear; thus he would avoid constipation in two ways, one by starting with figs, because as Galen teaches they soften and cleanse the intestines, the other by taking a compressive styptic like pears. The physician intended to counter [the patient's] flatulence with the nuts (which work more efficaciously taken with figs, because they are drawn to the intestines more speedily with something sweet).

After several days the patient was seized by a cough, which attacked him every day after a meal; believing that the amount of food he was eating was the cause, the physician ordered that it be cut back. When he saw that it did not stop, he prescribed things to soften the chest and lungs, and then finally because it still did not stop he asked the advice of another physician whom he knew. His friend asked to visit the patient, and once he had studied all the facts and had learned what had been prescribed, he suggested that [his colleague] try roasting the nuts that he was giving his patient and administering figs with those nuts at the time he had been giving the pear [i.e., at the end of the meal], and that [the patient] should begin [the meal] with a dried apple with sugar. This was done, and the cough ceased entirely in seven days. The physician came back to his friend to find out why the procedure had worked, and had it explained to him. Here, then, a contingency led to a change in what was

prescribed (as regards the apple), in the sequence (as regards the figs and nuts [which were deferred to later in the meal]), and in quality (as regards the roasting of the nuts).

With regard to a program of medication—which is only for the sick, because medicines are prescribed for directly countering an illness—three things ought to be seen to: first, that the medicines be chosen properly; second, that they be prepared carefully; third, that they be administered appropriately. Concerning their suitability two things should be provided for. First, suitability as to effects: for example, if the patient needs [a medicine] hot and dry in the second degree that the physician must select from the many with those qualities, mellissa or mint or the like, he should always choose that medicine, whether simple or compound, that will be of the greatest benefit to the patient and have the fewest harmful consequences. Second, suitability of that particular preparation, so that it be the strongest of its kind either absolutely or in relation to the illness for which it is prescribed: e.g., should figs (or ginger or dates) be given whole? Will this patient be better helped by figs from Persia or India or Damascus, or by Alexandrine or insular dates? There is great diversity found in things of the same kind, for example, plants that grow in the fields *versus* the same ones that grow in the mountains. As for the medicine itself, the physician should reflect on whether he can recognize it or not, and if he can he should ask to see it and judge it for himself. But if he is not acquainted with it, he should consider whether it has been described or depicted by the wise, and if so, when he has seen the plant, he should decide whether it corresponds to its description and [if so] choose it; while if it does not fit, he should not use it, but should choose instead something generally familiar and fitting the descriptions of the wise. And for students I give an example. You want to give eupatorium, but you are unfamiliar with it and the apothecary brings you wild salvia. If you want to avoid deception, be sure you know how the wise describe eupatorium. In this way a certain physician discovered an error in his practice concerning the use of eupatorium and spica celtica and many other medicines. In the preparation [of a medicine] the physician must consider, in order, the cleansing, grinding, measurement, softening, and mixing [of its ingredients]. He should give instructions to his assistants, the apothecaries, about its mixing, telling them when [it is to be prepared], lest lacking his instructions they make it up later than they should. As for its proper administration, he should inform the attendants of the amount and the time and manner of its administration—that is, how big the dose should be, and in what hour it should be given, and how (e.g., whether internally or externally, warm or cold, with fluids or without)—and with what [other treatment] (e.g., with strong or light massage), and so on. And he should always command the patient to be obedient to the attendants in following his orders at any hour. Thus we have seen in general from the aforesaid what the physician has to do himself, what he must know and what he must arrange and command; and we

have also seen how he must encourage the patient to confidence in and compliance with both his physician and his attendants; and how the physician should instruct the attendants.

It remains to take up a fourth thing, namely to consider extrinsic contingencies and their sequence, and to clarify this we must first know why they are called extrinsic. One opinion is that they are called external or extrinsic contingencies because they fall beyond the bounds of the rules of the art, as was said above. But taken strictly this would go against and contradict Hippocrates in his aphorism, since he says [there] that the physician must take into consideration—that is, consider and control—those things that are extrinsic; he therefore supposes that they fall under the practitioner's regulation, since he says they necessarily pertain to his consideration. This is why others want to say that they are extrinsic simply in the sense that they transcend the nature and force of the illness, as well as the common course and order of treatment. For the sound of bells, or the shouting of children and barking of dogs and rumble of carts, or the fire and wreck of a home, or flooding by rains and gusting of winds, or the rumor that something or someone beloved is lost, or the falling of a spider or scorpion into a jug, or other such things, when they befall a patient, do not do so as a result of his sickness or because of the natural powers of the things that must be used to treat him.

But there is still another problem: If such things are unforeseeable, how can the physician take them into account? The answer is that the physician can do so in three respects: he can consider them in themselves, or in their effects, or in their causes. In themselves they can be considered in either of two respects, one as regards the essence that they have when they act, the other as to their outcome, and they are uncertain in this latter respect because their outcome is not inevitable but contingent; in this manner they do not fall under the practitioner's consideration or reception, for he cannot know or control when and how they will act. But in the other three respects they do have some predictability, and to this extent they do fall under his consideration and regulation, though differently according to the differences in their predictability. For as to the first respect there is certainty to their existence; as to the second, of their possibility; as to the third, of their effectiveness.

In the first respect, therefore, he considers them as entities to be avoided. If a physician who enters the home of someone with ophthalmia (or cardiac problems due to heat, or a cough) should find it full of smoke, he should recognize how bad this is for his patient and should command that he avoid it completely. If the patient suffers from headache, especially migraine [*galea?*], the physician should react the same way, and if he notices barking dogs or shouting men or clashing cymbals outside the room, the patient ought [to be told] to avoid and shun them. When the physician observes such things, he can be certain that they exist, and so he can give orders concerning them. When he considers them as caused, then it is certain that they *can* exist, and then he can

respond by anticipating and preventing them. Finally, when he recognizes signs in the patient that are unrelated to the force and nature of the illness or to the common nature of curative causes, he can be sure that these are signs of some unforeseen contingency, and therefore he should proceed to investigate and remove or correct it. It is in these two last ways of coping with the contingent that the physician's foresight and acumen will be most brilliantly displayed, and therefore any intelligent practitioner ought to work at them diligently. Here Hippocrates has bestowed a wonderful present upon us; indeed, the wise esteem it the best of all his gifts that he chose to exhort us to take external contingencies into account, since the need to deal with them is ordinarily less obvious than are the other things that he touched on. Therefore if we apprehend his purpose and recognize the import of his words, we will find his teachings here and elsewhere to be a deep well of wisdom; but we will not share his treasure if we simply take over his words unthinkingly.

Let us therefore see what fruit these two approaches will bear in guiding our practice of medicine, see what a precious pearl Hippocrates has wrapped up for us in the fabric of his eloquence. Remember that extrinsic contingencies can be considered in their causes or their effects, by anticipating their causes and observing their effects, so that the anticipated may be guarded against and the observed corrected. For example, the physician finds that his patient's home is situated at the foot of a bell tower; he can anticipate that the bells might cause a noise that would be unpleasant and harmful for someone suffering from headache. Likewise he anticipates that where there are many dogs there can be importunate and annoying barking. Likewise if he finds a north or south window in line with his patient's head, he knows that when those winds blow the patient's head will suffer unless his bed is moved or the window is tightly shut. Likewise if he sees that the bottle of syrup or decoction stands uncovered in some corner or window and he finds spiderwebs over it, he can anticipate that spiders may get into these vessels. If he finds that the patient's house is roofless and open, subject to the gusts of the winds, he can foresee that a patient with dysentery who lives in such a place may incur gripes or other lesions of the stomach when any light air blows. Likewise if he is treating cancers or fistulas or swellings in the private parts and groin, and if these parts are exposed for any period of time, remaining so as long as the physician is at work cleansing or anointing or plastering, he can foresee that the patient may suffer problems with a chill in his hips or pains in the thigh or belly or other passions if he is not protected with hot air or warm cloths. If a patient suffers from hemorrhoids, or has recently had a rupture of the lungs, so that it would do him harm to get upset and he must speak in a low tone, the physician can anticipate that the patient will have reason to shout or perhaps to become angry if he has an attendant who is deaf or careless or sleepy. And so we see how, by anticipating future contingencies through their causes, physicians can usefully give

commands that will allow [the patient] to avoid harmful effects.

Now where a harmful effect appears in the patient that transcends the power of the illness and the common virtue of the curative causes, the physician can be certain that some unforeseen extrinsic contingency has intervened; he should therefore cast about, reflecting on all the things that he has used in his treatment, until he can identify the unforeseen contingency. But to be quick at this it will help to read through a table of the kinds and species of all medicinal healing agents that he can carry with him, if not in his heart then at least in a purse so that he can consult it more quickly. Once he has identified the contingency, he can correct the error. For example: a certain octogenarian physician, famous and experienced, wanted to use a steambath on account of his body's needs. He entered it one day and because he was old and weak in natural heat it did not seem to him that the air of the bath was hot enough; so he ordered lighted coals to be placed there, and a little afterwards one of his servants fainted and another, who himself was beginning to collapse, had to pull him out. Seeing his servant's condition, his master came out of the bath, and so that day he was unable to complete his treatment. The next day he wanted to go back in, but he did not want to bring with him the one who had fainted, and he called a young physician dear to him and asked him to consider and examine the lad's disposition, fearing from his collapse in the bath that some poisonous humor might be hidden in his viscera. Then the other servant who was there interposed, "Master, I think if I had stayed in a little longer the same thing would have happened to me, because I was already feeling my heart fail, and that's why I said I was afraid to go back." At this point the younger physician began to ask them whether they had entered the bath on a full stomach, and they said no. He asked if they had done anything just before, and they said no, except for this: he who had fainted said, "By my master's command, I heated the coals outside by blowing on them and then I entered the bath." Then the young physician replied: "The same thing will happen to you today if you bring live coals into the bath—for your master and lord right here well knows that man cannot live anywhere unless the air that is inhaled to temper [the heat of] the heart is colder or of weaker heat than the heart is. Because you young people, whose hearts abound in heat, were heating the air in the bath, you collapsed before your master did, but if he had stayed long he too would at last have been overcome." Then the old man, clapping his hand to his head, understood his mistake.[4]

It happened to another physician in this town that for his body's needs he commanded the preparation of a decoction of seaholly and licorice, on someone else's advice. A little after he took the decoction his bowels became upset, and he had pain and distress around the heart and vomited up the decoction and more; however, he did not attribute the event to the decoction but to other factors in his regimen. So the next day he again took a dose of the decoction and the same thing happened, still more severely. He was

alarmed and astonished, and he reported this to the physician on whose advice he had begun to use the decoction, who replied that since such an effect was no part of the strength and nature of the decoction, some extrinsic contingency must have intervened, and that therefore he should check to see whether something had fallen into the container, and if not, that he should carefully investigate the vessels or strainers or other things that had been used to prepare the decoction. And in the end the patient discovered that the decoction had been strained through an unwashed colander that had been used the day before to strain a decoction of hellebore.

It happened to another physician that every time he administered a decoction of *capilli veneris* [maidenhair fern] to a certain patient, the patient vomited excruciatingly; and finally after careful inquiry he found that the *capilli veneris* had been gathered in a large disused common cistern that still had a little water in the bottom. He went there to investigate and had himself shown the place where it was collected; and when he searched it carefully, he found the corpse of a toad at the bottom of the cistern, by which had been poisoned not only the moisture with which the plant was nourished but the air around it.

Again it happened to a certain healer who on the advice of another was making up a collyrium to remove a white film from the eyes that on the first night in which he instilled it into the eyes of his patient the man suffered an ophthalmia, with swelling and tumor and intolerable pain, and almost lost his eyes. The healer ran and told the principal physician, who replied that that was no part of the collyrium's properties, and because he was convinced of this he commanded that the collyrium should be made up again, following the same formula, and that [the healer] should prepare it in his home in such and such a way, as he had already been instructed. And it was instilled a second time into the eyes of the same patient and hurt him not at all; and after diligent inquiry into the previous instance it was found that the man who had made it up had ground up a large quantity of verdigris the day before and had then prepared the collyrium dressed in the same clothes that he had worn when he had ground it up.

Not many years ago it happened that a youth suffered a simple flux; but despite the many antidotes he used to constrict his belly, they did him no good, and he developed an uncontrolled dysentery. He consulted a physician, who asked what medicines he had used and learned that they were the appropriate ones. Then he asked what food and drink the youth took, and when he learned that his patient was using water from a cistern for drinking and cooking, he asked whether the cistern were of stone or cement. The youth answered, stone, but that the stone had been found to have several cracks through which it lost water, so that it had been newly cemented throughout, though more thickly at the bottom. The physician suspected from this that the calcinated water had given the patient his dysentery, which was confirmed by the results; for once he gave up using that water, he immediately began to improve markedly.

Again: a physician had a colleague in another city who was caring for a patient who had recently developed a hectic fever out of anger and sadness, and to avoid any reason for further sadness he had been moved to a lovely room, just refitted. But the patient daily got worse under his regimen and began to suffer tightening of the chest and headache. So when the aforesaid physician was passing through this city he visited the patient at the invitation of his friend, having already learned the history of the case from him. He studied the construction and condition of the room, and found that the walls were of plaster, the floor of cement, and the building entirely new; so he had the patient moved into another suitable room, and within two days the headache and tightness of the chest came to an end.

If I were to tell you all that I myself have seen and heard, the day would not be long enough to describe the cases to you. Still, these will suffice to show why the physician must take extrinsic contingencies into account, how they help shape his practice, and how they fall under the precepts of his art.

Notes

1. L. J. Rather, "The 'Six Things Non-natural': A Note on the Origins and Fate of a Doctrine and a Phrase," *Clio Medica* 3 (1968): 337–47; "'Six Non-Natural Things' in Galen," in *Galen und die hellenistische Erbe,* ed. G. Harig and J. Harig-Kollesch (Wiesbaden: Franz Steiner Verlag, 1993), 105–15.

2. On this subject, see Jole Agrimi and Chiara Crisciani, *Edocere Medicos* (Naples: Guerini e Associati, 1988), esp. ch. 5.

3. See, e.g., the Lyons, 1520, editions, 275va–81rb.

4. Luke Demaitre, "The Care and Extension of Old Age in Medieval Medicine," in *Aging and the Aged in Medieval Europe,* ed. Michael M. Sheehan, vol. 11, Papers in Mediaeval Studies (Toronto: Pontifical Institute of Mediaeval Studies, 1990), 14, sets this remarkable case in a wider intellectual context.

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Making Sense of Therapeutics in Seventeenth-Century New England

The title of this paper suggests two broad lines of inquiry. First, how did early New England physicians make sense of therapeutics? What did they know about disease and treatment, how did they learn what therapeutic measures were available, and what did they prescribe? Second, how can modern medical historians make sense of the therapeutics of the period? What judgments can we make about the state of medical practice in the seventeenth century and the efficacy of the colonists' therapeutic interventions?

One of the persistent myths about the Puritans who populated New England beginning in 1620 is the idea that they were so obsessed with matters of religion, spirit, and the afterlife that they were, by comparison, little concerned with the secular, the material, and the world of the living. Though their surviving religious notebooks and proofs of salvation recorded by ministers, if read alone, can lead to such an interpretation, one need only peruse their surviving personal letters addressed to family members and friends to see that while their religious beliefs played a significant role in ordering and interpreting their daily existence, the early colonists were very much interested with the practical affairs of living. In particular, they had a continual, almost obsessive, concern with matters of health and disease. Indeed, while their religion shaped ideas about the ultimate cause of illness, the experience of illness, in turn, was often used to shape religious consciousness, evidenced by ministers' frequent reliance upon medical metaphors to illustrate points of doctrine in their sermons.[1]

In their desire to return to the form and substance of what they called the "primative church," early New Englanders were by no means repudiating the accumulated scientific and technological knowledge of the centuries to return to an idealized "primative" society. As opposed to early Christians—who rejected sophisticated medical theories, practices, and learned doctors, and argued that prayers, common herbal remedies, and basic nursing were all that a believer need and should do—the heirs of Luther and Calvin saw the branches of "natural philosophy," including medicine, as gifts of God to be developed and made practical. However, consistent with their religious beliefs, Puritan practitioners of medicine, over the decades,

by Norman Gevitz and Micaela Sullivan-Fowler

would identify and seek to purge such "superstitious" and "ritualistic" elements of the healing art as charms, amulets, and other forms of magic (which they found objectionable) and adopt new rational understandings of the nature of illness, including new means and courses of treatment.[2]

Puritans who came to live in America during the first half of the seventeenth century considered themselves "English." Whether they initially practiced as physicians in England, took up the practice only when they reached New England, or were simply patients, it was to English conventions that they turned to help understand both the nature of disease and the appropriate therapies to be employed.

The English Therapeutic Tradition

In late 1618, after many years of discussion and one abortive publishing attempt, the Royal College of Physicians issued its first official dispensatory, a manual that was supposed to govern the preparation of drugs not only in the London area—which was the domain of the college—but the entire nation as well.[3] The College's product (published in 1650 by Nicholas Culpeper as *A Physical Directory; or, a Translation of the Dispensatory Made by the College of Physicians of London*) was both voluminous and eclectic. Almost twelve hundred items—leaves (292); animals, their parts and excrements (193); seeds and grains (144); roots (138); fruits and buds (93); flowers (85); metals and minerals (73); tears, fluid extracts, gums and resins (50); barks (34); juices (29); things from the sea (25); woods (16); salts (11); and plant excrements (7)—constituted the basis for the approved materia medica. Each item, or simple, could be combined with others to form compounded drugs that could take the form of syrups, juleps, decoctions, oils, electuaries, conserves, preserves, lozenges, ointments, plasters, poultices, troches, and pills.

The origins of the items found in what was called the London *Dispensatory* rest first and foremost upon an ancient empirical tradition among countless generations of healers in the Near and Far East, Africa, and Europe. To be sure, many ancient remedies, originally introduced into medicine because of their magical, ritualistic, and superstitious associations, are pharmacologically inert, but several of them and other empirically-evaluated simples can, in fact, produce certain predictable physiological effects. Some of these items—far more than an earlier generation of medical historians believed—may have provided physical benefits to the conditions for which they were prescribed. The London *Dispensatory,* issued more than fifteen hundred years after Dioscorides's *De Materia Medica,* was in fact heavily dependent upon Dioscorides's work as well as on other medical authors of the same era.[4] Indeed, out of the 162 animals listed in the *Dispensatory,* ninety were mentioned by Dioscorides; and of the seventy-three metals and minerals, fifty-four were cited in his *De Materia Medica*.[5]

Nevertheless, over the centuries, new items were added and others subtracted in various European, African, and Near Eastern manuals. Arabic writers, in par-

ticular, incorporated hundreds of new drugs; medieval and early modern European writers also developed their own combinations and prescriptions. Surviving middle English *antidotaries* (guides to drugs) testify both to the continuing classical tradition and to the presumed efficacy of indigenous botanical plants and native medical folklore.[6] As a result, the London *Dispensatory* selection of simples and prescriptions constitutes an amalgam of the ideas of many authors from different countries, cultures, and periods of time.

The selection of items incorporated in the London *Dispensatory* reflects the favored medical practices of the Fellows of the College of Physicians who contributed to it. Many fellows held divergent therapeutic beliefs, but all of their approaches appear to have been accommodated in the final product. For the remainder of the seventeenth century, the development of new drugs, along with this continuing process of individual accommodation, minimized the number of remedies that were dropped while maximizing the number of additions. By 1691, Salmon's version of the *Dispensatory* had more than eighteen hundred items, 53 percent more than the first edition.[7]

At the beginning of the seventeenth century, the diagnostic and therapeutic criteria for choosing a specific drug were still based primarily on theories posited by Galen of Pergamon in the second century A.D.[8] Most English physicians continued to believe that disease represented an imbalance among the four humors: phlegm, blood, black bile, and yellow bile. Humors and illnesses were classified by the primary qualities of hot and cold and the secondary qualities of dry and moist, which were reciprocally paired (i.e., hot/dry, hot/moist, cold/dry, or cold/moist) in determining the nature of the patient's illness at the bedside. Once the pairing had been recognized, drugs with opposite properties were chosen as appropriate correctives to the underlying humoral imbalance, although the physician also had to allow for individual factors such as the patient's age and gender, his or her natural temperament, and the season of the year. Thus, a patient with the watery eyes, dripping nose, and sneezing of a head cold (the term "cold" was itself a remnant of Galenic thinking) was perceived as having an excess of phlegm, which has the qualities of being cold and wet. To restore the humoral balance of such a patient, the doctor might prescribe pepper or ginger, both considered hot and dry primarily through taste. The choice of an appropriate drug was determined by the disease's intensity, by such patient characteristics as age, habitus, and temperament, or by the availability or cost of competing items.

Two aspects of Galen's thought that had lasting effects on medical practice were his reliance on bloodletting for a variety of disorders and his promotion of polypharmacy, recommending compounded drugs such as mithridate or theriac, each made up of dozens of ingredients, designed originally to prevent poisoning but later employed as all-purpose remedies. While Galenism, albeit here presented in an abbreviated form, offered a coherent, logical, and systematic approach to therapeutics, it was far

less beneficial to the patient than the empirically-based approach of Dioscorides that matched the use of specific drugs with the alleviation of specific symptoms without the encumbrance of a theoretical superstructure that tried to explain all things.

The first comprehensive assault on Galenical therapeutic thinking had come from Theophrastus Bombastus von Hohenheim, or Paracelsus (1493–1541), some of whose medical ideas gained prominence in England in the early-to-mid-seventeenth century.[9] Paracelsus postulated a chemical basis of the universe—arguing that the three principles of nature were the combustible, the vaporous, and the solid—as metaphorically represented by the substances of mercury, sulphur, and salt, respectively.

Paracelsus also dispensed with the idea of humoral pathology. Conceiving of the body as a grand chemical laboratory and each of its organs as specialized laboratories, he argued that disease was the result of chemical disturbances, possibly caused by malfunction of a given organ, with symptoms localized in that organ or in the part of the body nourished by that organ. Obvious examples might be kidney and bladder stones, gout, rheumatoid arthritis, calcified lungs, and stomach ulcers.

Paracelsus's theory of disease was accompanied by a rejection of both Galenic polypharmacy and conventional methods of preparing drugs. Instead of the usual vegetable and animal materials—which were simply dried, mixed, decocted, or infused before being administered to the patient—Paracelsus argued for "pure" remedies that could be sublimed, distilled, and resolved from crude materials, giving special emphasis to the therapeutic benefits of metals and minerals. He introduced new mercurial, antimonial, and iron compounds as well as laudanum, a preparation of opium in wine that was quickly and widely accepted for the relief of diarrhea, insomnia, and pain.

Many of Paracelsus's writings are clouded by religious mysticism, odd metaphors, occultism, and astrological speculation and are marked by bitter denunciations of accepted authorities, poor organization, and inconsistent writing style. Nevertheless, he influenced a growing number of Puritan physicians, many of whom ignored his more extreme medical and metaphysical views, leading to an expansion of interest in chemical medicines—an area of research and scholarship that antedated Paracelsus himself. Although many early- to mid-seventeenth-century physicians did not abandon Galenism as a result of Paracelsus's attacks, his intriguing alternative to Galenic pathology, his emphasis on challenging authority, and his call for experimentation opened the door for more questioning and greater eclecticism by practitioners. Indeed, during the period of the "Great Migration" to America, Puritan physicians had already fused elements of Galenic and Paracelsian thought, whatever their theoretical incompatibilities, into a reasonably coherent system of medical practice.

New England Therapeutic Practices

The first generation of New England doctors boasted few university medical graduates or formally-apprenticed surgeons. The great majority of male practitioners came into medicine from other careers. Some were university-educated Puritan clergymen who learned something of medical practice as a useful adjunct while ministering to their congregation or as an occupational fallback in case their religious convictions should cause them to be silenced by the bishops.[10] While clerics did provide a significant share of medical care in New England, they were outnumbered by secular practitioners who acted not only as healers but also as farmers, blacksmiths, tailors, butchers, or merchants.[11] Inventories taken at their deaths show that New England physicians, both clerical and lay, read general textbooks like those of Phillip Barrough, Christoph Wirsung, John Woodall, and James Cooke; popular medical guides, particularly those by Nicholas Culpeper; herbals by Rembert Dodoens and John Gerard; and various collections of medical prescriptions.[12]

Although largely self-taught, clerical and secular physicians and surgeons won ready acceptance in New England. Similarly trained practitioners who plied their medical skills in old England were, by contrast, excoriated by learned, university-educated physicians for gross incompetence and noxious meddling.[13] One of the central arguments of English anti-quackery writers is that nonacademic practitioners had no rational understanding or appreciation of medical theory. Instead, they worked empirically, prescribing medicines they thought would correct given symptoms without understanding the nature of disease or the rationale for specific therapeutic intervention. Although this was a valid criticism, the empirical approach could, indeed, allow practitioners to judge the relative efficacy of their remedies—not on the basis of an abstract set of ideas but, on a more practical level, by whether they "wrought well" in real patients.

In fact, New England practitioners throughout the seventeenth century took little interest in theoretical matters. Some were principally Galenic in their approach, preferring traditional remedies; others were Paracelsian, distilling their drugs and emphasizing the employment of metals. Most physicians appear to have gone about their business employing remedies from whatever tradition seemed to produce the best results. They also readily set aside theoretically-based material from otherwise valued sources that they considered incompatible with their own world view. For example, many New England physicians read the books and voraciously copied the ingredients of Culpeper's medical recipes while simultaneously ignoring his putative astrological signs for individual plants.

New England physicians, recognizing differences in theoretical approaches, were content to understand the properties of a drug not on the basis of how or why it cures, but on the basis of what it does. Colonial doctors followed standard European terminology and classifications of the general physiological actions of drugs. For example, they

referred to emollients (softeners of tumors and hardness), carminatives (agents that expel wind), anodynes and narcotics (pain relievers), diuretics (openers of the kidneys and bladder), emetics (that produce purging by vomiting), cathartics (that produce purging by stool), and emmenagogues (that provoke menstruation). New England physicians also referred to remedies by the specific sites where they acted, calling them cephalick, pectoral, cardiack, stomachick, hepatick, splenetick, nephritick, hysterick (i.e., uterine), and arthritick—the latter referring to any of the joints.

In trying to determine the actual therapeutic and prescribing patterns of early New England physicians, we draw on three types of manuscript sources. The first are apothecary orders that tell us what drugs were prescribed by physicians, although these records do not tell how these items were used, or for what problems. The second set of primary sources are physicians' letters to patients—essentially a seventeenth-century version of the medieval *consilia*—that reveal what drugs physicians prescribed for patients at a distance, although such recommendations might have differed from those the same physicians would have made at the bedside. The third source is the *vade mecum,* essentially an eclectic storehouse of knowledge gathered by individual physicians from many sources. Such personal compendia may outline a range of therapeutic possibilities for a given complaint, but often do not tell us a physician's personal drug preferences, whether he actually ever used any of the recipes he collected, or, if he did use one of them, with what success. Unfortunately, a fourth set of primary source materials, ordinary physicians' account books, with which Worth Estes has drawn significant conclusions about day-to-day eighteenth-century New England therapeutic practices, do not appear to have survived from our much-earlier period.[14]

Apothecary shops had been established in Boston as early as the 1630s, but surviving New England apothecary orders and records date only as far back as the 1670s. The earliest surviving order appears to be a list of drugs requisitioned in 1676 by William Locke, who had recently immigrated to New England and was attached soon after to the Massachusetts troops fighting the Wampanoag and Narragansett Indians in King Philip's War (1675–1676).[15] In May 1676, Locke urgently implored the secretary of the Massachusetts Bay Colony to send twenty-eight remedies for use in treating his patients. Included in his list were powder of aloe, oil of terebintha (turpentine), linimentum arcaei (an astringent liniment), emplastrum de mellilot (sweet clover plaster), and other cleansing agents, unguents, liniments, and watery poultices applied externally for the debridement, softening, and lubrication of wounds and skin. Locke also asked for cathartics, astringents, carminatives, emollients, and stomachics such as spirit of cinnamomum (cinnamon) and oxycroceum (a saffron plaster). The great majority of these and such remedies as betony, liquorice, and cloves were not native to New England. Even such elementary herbs as chamomile,

roses, and anise, which Locke might have had at his ready disposal if he were settled in a community or cultivated his own physic garden, had to be requisitioned. He ordered a number of opiate compounds—diascordium, mithridate, theriac, and aqua thericalis—that would be useful for their narcotic, sedative, and antidiarrhoeal properties.[16]

The military nature of Locke's order is evident when compared to a lengthy list of medicines more appropriate to a civilian practice needed in 1677 by Dr. Daniel DeHart of New York.[17] DeHart's patients included women, as evidenced by his request for emmenagogues like myrrh and castoreum, and the expensive confectio alkermes, an electuary made from a scarlet pregnant female insect that resided in the evergreen oak, to hasten birth and prevent abortion. DeHart also ordered Aqua Stephani, a "strong water" made from cinnamon, ginger, cloves, nutmegs, fennel, and nineteen other ingredients, infused in Gascoign wine and prescribed for women in labor or for menstrual difficulties. Other less gender-specific remedies ordered by DeHart included magisterium corallorum (a white precipitate of coral dissolved in vinegar and tartar employed for treating fluxes, hemorrhages, and weakened heart) and spear cochlear, distilled from the flesh of snails, which was, according to Culpeper, excellent against consumptions.

In 1684 and 1685, the apothecary Benjamin Davis of Boston filled orders for Dr. Thomas Pemberton and a Dr. Williams, both of the Bay Colony, and for Dr. John Pane of Long Island.[18] Each of these practitioners appears to have relied on a limited number of drugs for multiple clinical indications. While all three orders included opium preparations, individual preferences characterize the lists of each practitioner. Pemberton used metallic remedies for producing emesis and treating wounds. He ordered crocus metallorum, which incorporated antimony oxide; vin emetic, an antimonial preparation in Spanish white wine; unguentum diampholyx, made of white lead and belladonna; and red mercuric oxide. For general measures, Pemberton seems to have favored cordials, electuaries, and cathartics like those containing saffron, aloe, jalap, and damask roses. He treated inflammations, intestinal problems, and fevers with, for instance, mellilot, juniper berries, and an epispastic (the blistering agent cantharides or Spanish flies). He ordered oil of cloves and plasters of cumin seeds for patients who needed stimulating aromatic remedies. Pemberton's most unusual request was for leaves of gold, a remedy touted by some because of the rarity and perfection of the metal, which would, by correspondence, work wonders when employed as a general therapy. Nevertheless, its high cost, the dubious logic underlying its use, and the lack of demonstrable physiological effects made it an uncommon medicine in New England.

Dr. Pane ordered lead-based ointments and plasters, such as white lead and red lead, presumably for their cooling, drying, and astringent properties when applied to wounds and skin problems. He also ordered diuretics,

cathartics, and irritants. Among the specific drugs Pane ordered were nutmeg and its more potent cousin mace, oil of capers, liquorice, pix burgundy made from the resin of spruce fir, wormseed (an anthelmintic whose clinical purpose was indicated by its name), and pepper, which, even when stripped of its Galenic qualities, was still found useful for improving digestion, relieving nausea, and treating hiccups.

Dr. Williams's order of thirty-four medicines was the longest and most comprehensive of the three, consisting of both vegetable and metallic remedies, many of which had a broad range of indications according to textbooks of the time. His basic arsenal included amber, opium, calomel, saffron, saltpeter, senna, white coperas (zinc sulphate), birthwort, castor oil, cinnamon, gentian, mace, and Aqua Stephani. However, Williams also ordered less common, or new and exotic, remedies as cortex Peruviana (also known as cinchona), which was truly effective in combatting the symptoms of malaria. Cinchona had recently been introduced into the colonies and its use expanded into that of a general restorative remedy during recuperation from all sorts of debilitating fevers. Other items on his list are sagapenum, spirit of cornu cervi (smelling salts), pil hiracum agarico (a styptic made with a fungus), and syrup of buckthorn. The most dangerous medicine he ordered was black hellebore, a powerful cathartic that experienced physicians knew had to be used with caution.

What do the lists of Locke, DeHart, Pane, Pemberton and Williams tell us? First, they reflect the integration of the traditional Galenic approach with the Paracelsian or chemical remedies. Second, while all these lists are similar with respect to the categories of drugs and the individual remedies ordered, they reveal personal differences and preferences among the five physicians, indicating that late-seventeenth-century New England practices could be diverse and unstandardized. Third, comparing these lists with various editions of the London *Dispensatory* shows that however individualistic their prescribing patterns, our sample doctors were ordering drugs listed in at least one widely accepted authoritative guide. Fourth, except for Dr. Locke's military requisitions, the drugs they ordered were either compounded items that they could not manufacture themselves or plant simples that did not grow in New England soil.

This leads to a question that would be appropriate to address here: did the total number of the drugs requested by each of these physicians (from eighteen to thirty-four) reflect the total number of apothecary-manufactured drugs that they would generally have on hand? It is certainly possible that these lists constituted only requests for those items of which they had run low, and that their actual stocks of drugs may have been considerably larger. One possible way to determine physicians' stocks on hand would be to examine inventories taken after their deaths. Unfortunately, inventories for New England practitioners that we have uncovered list only the total value of drugs on hand, never their number. We do know that when Dr. Phillip Lane of New York died in 1677, his in-

ventory of drugs numbered twenty-two, and did not differ appreciably from the lists of the physicians in our sample.[19] Thus, although we must be cautious about extrapolating from a single case, especially one outside our region, the data taken as a whole at the very least suggest that the physicians we have studied kept in stock only the small fraction of approved drugs that formed the core of their therapeutic practices. They obtained the remainder of their drugs from their own (or their patients') gardens or from convenient orchards, fields, meadows, and forests.

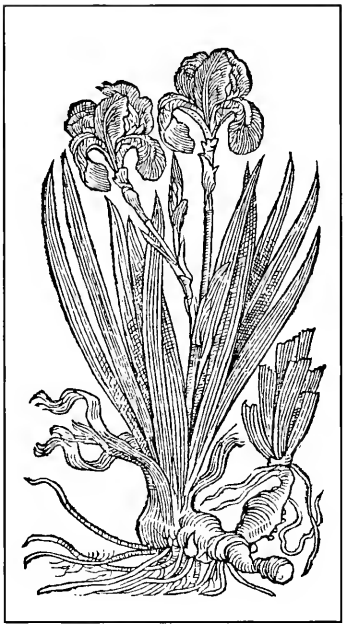
The second type of primary source, i.e., letters written to patients or family caregivers, show how and why physicians used certain drugs. The earliest surviving example of such correspondence is a letter written in 1652 by John Winthrop, Jr., of Connecticut to Richard Odell of Long Island, whose child was suffering from palsy.[20] Since no apothecary was conveniently located for Odell, Winthrop prepared some of the medicaments he recommended and sent them along with his advice. He told Odell it was necessary to keep the patient warm (palsy was historically regarded as a cold disease). He recommended wrapping the child in "hares or Fox furre" and anointing the weak areas with hot oils such as rosemary, thyme, or marjoram, and suggested oil of castoreum mixed with oil of worms and fox grease. He also sent an ointment, the ingredients of which he did not specify, which was to be rubbed not only on specific weak areas of the patient's body but also upon the "whole back bone," to create heat and facilitate motion. Cupping glasses (used to bring blood to the affected area) were proposed, to be followed by a plaster of colophony (also known as Greek pitch), frankincense, rosin, powder of bayberries and mellilot. As for diet, Winthrop suggested a decoction of guaiacum and sarsparilla or spirit of rosemary taken in beer. If the patient was not too debilitated, he advised bloodletting from an unaffected limb.

In 1673, Dr. William Avery of Dedham, Massachusetts, wrote to Josiah Winslow of Marshfield, in Plymouth Colony.[21] Avery apologized for not being able to see him in person, but advised Winslow on how to treat his distemper of the small bowels. Avery recommended that Winslow begin treatment with a purge of rhubarb along with aniseed, fennel, saffron, and sugar in "good wine." After the gentle working of this cathartic medicine, Winslow was advised to imbibe a drink made of anise, fennel, mallow, and hollyhock seeds combined with parsley, fennel roots, and liquorice boiled in water. Avery also suggested an unidentified herb from England (which may have been parsley piert) that would enhance the drink further. Next, he recommended syrup of iris or flower de luce boiled with sugar. At the end of his letter, Avery advised his patient to be leery of sharing his recipe with unscrupulous practitioners who would use it for personal gain, and to reveal it only to those who truly wished to benefit the sick.

Sometime around 1683, Samuel Torrey of Massachusetts wrote to Thomas Hinckley of Barnstable on Cape Cod.[22] Hinckley's grandchild had just died of an unnamed disease. Torrey, himself not a

physician, had asked his father to find out what should be done in a case such as this, and forwarded the information for use in the future to Hinckley. The advice appears to reflect both professional and domestic practice. The elder Torrey's source first recommended a vomit of crocus metallorum to be followed by Rufus's pill, a cathartic. Next, treacle water colored with saffron was to be administered orally, to produce a sweat, followed by a clyster (enema) of barley, butter, sugar, and two egg yolks. If the problem continued, blistering plasters would be needed. In addition, drinks of barley water including aniseed, liquorice, figs, raisins, maidenhair fern, and pimpernel were indicated. Stallion dung could be applied to painful sites. However, a decoction of strawberry leaves, five-finger, violets, and columbine boiled in spring water and sweetened with honey was indicated if the pain was in the mouth.

These primary sources give a somewhat fuller picture of therapeutic philosophy and practices. The drugs recommended are remedies that appear familiar to laypersons, locally grown or easy to procure. Anise, fennel, iris, parsley, barley, columbine, strawberry leaves, violets, rosemary, sarsaparilla, and the like were either indigenous, naturalized, or so commonly imported as not to be difficult or expensive to acquire. Most of the remedies mentioned would have been relatively easy for the patient or family members to prepare. Such decoctions, baths, syrups, and plasters were regular features of home medicine. Furthermore, nondomestic remedies like crocus metallorum and



Iris, or fleur-de-luce, in John Gerarde,* The Herball, or General Historie of Plantes, *ed. Thomas Johnson, 2nd ed. (London: Adam Islip, 1633). This was one of the reference sources most often consulted in colonial America.

Rufus's pills were among the items most commonly stocked by any apothecary. It is noteworthy that Winthrop recommended many items to his isolated Long Island correspondent that the latter might easily have obtained even without an apothecary; he did not mention chemical remedies such as nitre, antimony, sal prunella, alum, and vitriol, drugs which were more characteristic of Winthrop's usual therapeutic approach.

Certain patterns of care can be discerned in all three letters. In Winthrop's choices of remedies for palsy, we see

that his purpose was to heat where there is cold, to stimulate where there is weakness, to accelerate the circulation where there is obstruction, and to nourish when strength had to be restored. Winthrop's approach is traditional, rational, and defensible. We also see a logic behind the sequencing of specific therapeutic interventions in these letters. Avery and Torrey's informant begin their regimens with a purge, to clean out the system, followed by a restorative, to strengthen the body through rehydration or nutrition, and conclude with remedies for the special symptoms of each patient. This, too, is a traditional approach, one which was expected by patients and which conformed to common sense.

The third type of manuscript source for seventeenth-century therapeutics is the *vade mecum*, a physician's book of notes, collected from both his readings and his own experiences as well as those of other practitioners. Space allows us to consider but one of these manuscripts, the *vade mecum* kept by Thomas Palmer of Middleboro, Masssachusetts, which is dated 1696 although its contents are of earlier origin.[23] Of all the surviving primary materials of this type, Palmer's is the most comprehensive. The originality of the form and content of the work continues to be studied by the present authors; it is sufficient to note here that a number of seventeenth-century writers are cited in the body of the text, which also credits the *vade mecums* of other New England physicians.

The manuscript's first important section is a list of practical rules for attending sick patients and practical signs of death or life, all of which are reminiscent of Hippocratic prognostics. There are brief introductory comments on humors, astrological signs, bloodletting, consumption, pills, constipation, therapeutic oils, plasters, cordials, and other ailments and swellings, all of which precede the main body of the work, which is an alphabetical listing of diseases from "Agues & Fevers" to "Whites in Women."

The parts of the body that Palmer mentions most often are the belly and/or stomach. He describes twenty-six different conditions (e.g. "gripping the belly," "belly bound," "nauseaus stomach," "wind in belly," etc.), followed by eleven descriptions of conditions of the flesh (such as callous, corrupt, and livid) and varied conditions of the lungs (eight), heart (eight), liver (six), kidney (six), and spleen (six) . The amount of detail in Palmer's descriptions can be understood as an attempt to differentiate symptoms so as to enhance therapeutic specificity and therefore, efficacy. Thus, rather than simply listing "cough," Palmer's text refers to consumptive cough, inveterate cough, tickling cough, vehement cough, chin cough, etc. and for each type of cough he reports a different therapeutic approach.

The total number of therapeutic agents (most recipes have anywhere from two to fifty ingredients) is 917. The great majority, 646 (70 percent), are derived from the vegetable kingdom, including herbs, plants, nuts, barks, resins, and alcohol. Animal substances, of which there are 152 (16 percent), comprise the second largest category, represented by insects, dung, fats, and

other products. Minerals comprise 109 items (12 percent), including metals, salts, and gems. The remaining ten ingredients are types of waters. These 917 ingredients were indicated for 519 different clinical problems, from consumptive cough to "paines of chollerick humors," from strengthening the liver to curing gangrene. The vast majority of these items are found in various editions of the London *Dispensatory*.

The ten most commonly recommended active ingredients or remedies are roses (in the form of syrups, waters, leaves, conserves, etc.) with 163 indications, followed by vinegar (87 indications), opium preparations (80), angelica (72), wormwood (64), ginger (59), rhubarb (54), fennel (51), rue (51) and anise (49). Sage, aloes, turpentine, mithridate, saffron, camomile, hyssop, and senna are the next most commonly used. While minerals are significantly represented in the Palmer manuscript, their uses are more circumscribed, and few have more than thirty indications. Vitriol, lead compounds, cream of tartar, and alum find several uses, but recommendations for antimony, arsenic, and mercury compounds are few.

Besides the most commonly used presumably active drug ingredients, a number of substances were used to make recipes palatable, or to provide a vehicle in which the rest of the recipe might be administered. These materials include butter, honey, milk, whey, waters, sugars, and various alcoholic beverages. However, all of them were sometimes regarded as having nutritive or even therapeutic value as well. When faced with ingredients like agaric or bull bile, patient compliance and satisfaction were surely increased by ameliorating the drug's taste. Alcoholic beverages in the form of beer, cider, ale, wine, sack, rum, or muscatel were frequently used as vehicles because of their remedial properties, because they were widely regarded as safer to drink than untreated water, and, quite often, because the active drugs would dissolve more completely in alcohol than in water.

Palmer's manuscript, more than the other types of primary documents discussed here, also allows us to consider the role of bloodletting in the therapeutic picture in seventeenth-century New England. William Douglass, a university-trained physician who emigrated to Boston in the early eighteenth century, noted that, before his arrival, local physicians relied heavily on bloodletting for all sorts of medical problems.[24] Among the 519 conditions we differentiated in Palmer's *vade mecum,* bloodletting is recommended for forty-three conditions (or 8.3 percent). This is an unexpectedly low percentage of the total range of conditions, which might suggest that use of the lancet was relatively circumscribed. However, the employment of bloodletting depended more upon the frequency of Palmer's forty-three conditions in the late seventeenth-century. Indeed, his manuscript recommends bleeding for significant and common conditions such as ague, fever, gout, headache, inflammation, madness, smallpox, dropsy, sciatica, and consumption. These conditions raise the possibility that the frequency of bloodletting might have been higher in actual practice than the simple percentage of conditions for

which it was indicated would suggest. Nevertheless, it would appear that Douglas's characterization of bloodletting's primary role in therapeutics, short of any other documentation, must be treated with some scepticism.

Of Efficacy

How can we evaluate the efficacy of the therapeutics employed by seventeenth-century New England physicians? Certainly, physicians of any time and place need to address medical problems that are socially and culturally influenced. This means that, in order to practice successfully, seventeenth-century New England physicians had to recognize disease, follow its course during treatment, and use acceptable therapies in ways that conformed with the expectations and the knowledge base of their patients. While the issue of whether a patient gets better following treatment is a significant element in considering the value of the treatment, this is not the only criterion that physicians, patients, and families used when judging whether treatment was appropriate. In therapeutics, the question of appropriateness in seventeenth-century New England came down primarily to two issues: first, whether the drugs used were able to produce the specific physiological effects that were intended; and second, whether these remedies were perceived as relieving or eliminating the principal symptoms that brought the physician to the aid of the patient in the first place.

On each of these two tests, early New England physicians had the therapeutic armamentarium to do reasonably well by their patients. In their efforts to produce specific physiological changes in the body, they had reliable emetics and cathartics, they had drugs that made patients sweat, they could expel wind, cause the patient to sleep, and to void water. With respect to symptomatic relief, their drugs could on occasion ameliorate pain, reduce fever, relieve itching, stop nausea, and end both constipation and diarrhea.

But did the remedies work effectively against disease? This question poses two general problems. The first consists of the lack of sufficient modern knowledge about the pharmacologic powers of the drugs they employed as well as the paucity of information about the precise clinical circumstances under which seventeenth-century New England physicians used specific drugs, the strength of their preparations, the dosage given, as well as related issues of drug identification, preparation, and administration. The second problem is the danger of historicism. Is it fair, or even worthwhile, to judge the efficacy of yesterday's remedies by the values, beliefs, standards, and practices of today? Certainly, it does not seem reasonable to us to simply judge the efficacy of a given seventeenth-century drug as to whether it currently occupies a place in modern dispensatories for the same conditions it was used for back then. While a small fraction of early colonial drugs does pass this test, it does not necessarily follow that remedies not currently listed must have had no value. Most drugs employed by seventeenth-century New England physicians have not undergone structured, much less double-blind, clinical

trials, nor is there any likelihood that many of these items will ever be so tested. Nevertheless, it is interesting that modern research on contemporary folk remedies, some of which are the same as or botanically related to plants used by seventeenth-century practitioners, reveals that some produce abortions, some prevent conception, some have antibacterial properties, or act in ways consistent with their use by early New England practitioners.[25] Still, we are not prepared to make a leap of faith. Such isolated positive findings, when considered along with the intractable problem of not knowing precisely how New England physicians employed particular drugs, simply militates against making broad generalizations with respect to efficacy. At the same time, this ongoing ethnopharmacologic research should also serve as a caution to modern-day medical historians of the danger in cavalierly dismissing the therapeutics of the period as a collection of inert, irrational, and worthless remedies, without presenting compelling evidence to document their assertions.

■

Notes

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2. For discussion of magical elements in medicine, see Keith Thomas, *Religion and the Decline of Magic* (New York: Charles Scribner's Sons, 1971); Richard Godbeer, *The Devil's Dominion: Magic and Religion in Early New England* (Cambridge, Eng.: Cambridge University Press, 1992); and Martha R. Baldwin, "Toads and Plague: Amulet Therapy in Seventeenth-Century Medicine," *Bulletin of the History of Medicine* 67 (1993): 227–47.

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5. William Brockbank, "Sovereign Remedies: A Critical Depreciation of the 17th-Century London Pharmacopoeia," *Medical History* 8 (1964): 1–14.

6. Tony Hunt, *Popular Medicine in Thirteenth-Century England* (London: D. S. Brewer, 1990), 1–63.

7. William Salmon, *Pharmacopoeia Londoninensis*, 4th ed. (London: For T. Bassett, 1691).

8. For Galen, see George Sarton, *Galen of Pergamon* (Lawrence: University of Kansas Press, 1954); John Scarborough, *Roman Medicine* (Ithaca: Cornell University Press, 1969); Owsei Temkin, *Galenism* (Ithaca: Cornell University Press, 1973); Galen of

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9. Nicholas Goodrick-Clarke, ed., *Paracelsus: Essential Readings* (Northamptonshire: Crucible Press, 1990); Allen G. Debus, *The English Paracelsians* (New York: Franklin Watts, 1966).

10. See Patricia Ann Watson, *The Angelical Conjunction: The Preacher-Physicians of Colonial New England* (Knoxville: University of Tennessee Press, 1991).

11. See Norman Gevitz, "Samuel Fuller of Plymouth Plantation: A 'Skillful Physician' or 'Quacksalver'?" *Journal of the History of Medicine* 47 (1992): 29–48.

12. Phillip Barrough, *The Method of Physick* (London: R. Field, 1629); Christoph Wirsung, *The General Practise of Physicke* (London: J. Legate, 1617); John Woodall, *The Surgions Mate* (London: E. Griffin, 1617); James Cooke, *Mellificium Chirurgie; or the Marrow of Many Good Authours* (London: Samuel Cartright, 1648); John Gerard, *The Herball, or General Historie of Plantes* (London: Adam Islip, 1633); Rembert Dodoens, *A Niewe Herball; or, Historie of Plantes* (London: G. Dewes, 1578); and Nicholas Culpeper, *The English Physitian* (London: Peter Cole, 1652).

13. See, for example, John Cotta, *A Short Discoverie of the Unobserved Dangers of Severall Sorts of Ignorant and Unconsiderate Practisers of Physicke in England* (London: R. Field, 1612). See also Norman Gevitz, "'Helps for Suddain Accidents': Stephen Bradwell and the Origin of the First Aid Guide," *Bulletin of the History of Medicine* 67 (1993): 51–73.

14. J. Worth Estes, "Therapeutic Practice in Colonial New England," in *Medicine in Colonial Massachusetts, 1620–1820*, ed. Estes, Philip Cash, and Eric Christianson (Boston: Colonial Society of Massachusetts, 1980), 289–383; Estes, "Patterns of Drug Usage in Colonial America," *New York State Journal of Medicine* 87 (1987): 37–45.

15. "A Drug List of King Philip's War," *Badger Pharmacist* 26 (1939): 1, 4.

16. In identifying these drugs and their uses, we have employed the versions of the London *Dispensatory* by Culpeper (note 3) and Salmon (note 7). In addition, J. Worth Estes's *Dictionary of Protopharmacology: Therapeutic Practices, 1700–1850* (Canton, Mass.: Science History Publications, 1990) proved quite valuable. Though most of the drugs used in the seventeenth century were also employed in subsequent decades, some of their uses, as recorded by Estes, change. For example, a therapy serving as a "tonic" reflects eighteenth-century medical theory and practice.

17. Kenneth Scott, "New York Doctors and London Medicines, 1677," *Medical History* 11 (1967): 395.

18. Jeffries Family Papers, Records of William and Benjamin Davis, Apothecaries of Boston, Massachusetts Historical Society, Boston.

19. Scott, "New York Doctors," 395–97.

20. See Malcolm Freiberg, ed., *Winthrop Papers . . . Volume 6* (Boston: Massachusetts Historical Society, 1992), 229–33; Ronald Sterne Wilkinson, "'Hermes Christianus': John Winthrop Jr. and Chemical Remedies in Seventeenth-Century New England," in *Science, Medicine and Society in the Renaissance*, ed. Allen Debus (London: Heinemann, 1972), 228–29.

21. William Avery to Josiah Winslow, Sept. 23, 1673, Massachusetts Historical Society.

22. Samuel Torrey to Thomas Hinckley, n.d., *Collections of the Massachusetts Historical Society* (Boston: Massachusetts Historical Society, n.d.), Ser. 4, 5:111–12.

23. Thomas Palmer, comp., *Admirable Secrets in Physick and Chyrurgery* (1696), photostat, Massachusetts Historical Society.

Thomas R. Forbes transcribed and edited the manuscript for publication in 1984 under a similar title by Yale University Press. His transcription has many errors, however, which we have tried to avoid in our reading and in our statistical analysis.

24. William Douglass, *A Summary, Historical and Political, of the First Planting, Progressive Improvements, and Present State of the British Settlements in North-America,* 2 vols. (London: R. Baldwin, 1755), 2: 350–52.

25. John Riddle has laid open to question the conventional wisdom that assumes the inefficacy or worthlessness of classical, medieval, and early modern pharmacotherapeutics. In a number of ways his arguments are stimulating, particularly with respect to the significance of the findings of recent pharmacologic research. At the same time, he is more willing than we to build a speculative and circumstantial case for the overall efficacy of early therapeutics. In addition to his volume on Dioscorides (note 4), see Riddle, *Quid Pro Quo: Studies in the History of Drugs* (Hampshire: Variorum, 1992) and his *Contraception and Abortion from the Ancient World to the Renaissance* (Cambridge, Mass.: Harvard University Press, 1992).

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The Chemical Revolution and the Art of Healing

Much of the early formation of chemistry is embedded in the practice of medicine. Among the deepest of its roots were operations devised to prepare and purify substances with medicinal virtues. During the seventeenth century, however, there gradually coalesced a scientific discipline whose purpose was stated in terms more general than its practical applications. One of the most successful teachers of this emergent field, Nicolas Lemery, typically defined chemistry in 1672 as "an art which teaches how to separate the different substances composing a mixte," whether the latter derived from the animal, the vegetable, or the mineral kingdom. That chemistry remained, nevertheless, connected most intimately with medicine was symbolized not only by the fact that Lemery regularly enumerated the medicinal properties of the chemical preparations he described but also that he appealed to the dean and regents of the Faculty of Medicine of Paris for their support, on the grounds of the "very great usefulness of true chemistry" in medicine.[1]

A common belief about the subsequent history of this relationship is that the modern "service" of chemistry to medicine was made possible only by a long intervening phase in which chemistry slowly established its independence from medicine. According to this view, the chemical revolution led by Antoine Lavoisier was a culminating step in the liberation of chemistry from its former "thralldom" to medical needs. Out of the chemical revolution arose, in the early nineteenth century, the powerful subfield of organic chemistry, which spawned in its turn biochemistry, pharmacology, and all the other chemically based subfields responsible for the vast modern repertoire of methods applicable to medical diagnosis and therapy.[2]

Seen from a distance, reduced to broad trends extending over a long time, this picture retains a certain validity. It overlooks, however, the complexity and multiplicity of events within early chemistry visible at closer ranges. Even as some directions of eighteenth-century chemical investigation and teaching led it into realms beyond the domination of medicine, other investigative movements maintained, and sometimes strengthened, the traditional association of chemistry with medicine. Most eighteenth-century chemists were either medically trained or were apothecaries;

by Frederic L. Holmes

many were teachers of medical students, and most were eager to demonstrate that the new chemical discoveries promised new insights into the nature of disease or new means to treat disease. Lavoisier himself was exceptional in his lack of a medical background, but he, too, sought to apply his results to medicine and public health. From his theory of respiration, for example, he derived not only consequences for maintaining the salubrity of the air in public places but also conjectures concerning the nature of diseases. His two most prominent chemical supporters, both physicians, went further. Claude Berthollet extended the discussion of the relation of respiration to diseases, and he sought to explain the actions of medicaments on the basis of the new concepts of chemical composition introduced by Lavoisier's chemistry. Antoine Fourcroy pursued systematically the idea that the actions of some medications were due to the oxygen that entered their composition. In France, as well as England and Germany, converts to the new chemistry began to apply it to the theory, teaching, and practice of medicine. "After having shaken the old foundations of physical theory," Fourcroy enthused in 1798, "the revolution in chemistry must extend to all parts of the natural sciences, and none will receive a greater and more rapid transformation than the art of healing."[3]

Nutrition, Health, and Disease

Just as the new chemistry that Lavoisier and his supporters established displayed more continuity with earlier chemistry than is sometimes recognized, so did their efforts to apply its results to medicine continue earlier efforts to explain health and disease through chemical processes and to explain the actions of medicaments by their chemical qualities. The corpus of learned medical theory and practice was, by the mid-eighteenth century, an intricate blend of tradition and novelty. A humoral pathology consciously traced to classical Hippocratic medicine, but deeply altered by multiple metamorphoses, coexisted with—sometimes in competition with, sometimes loosely integrated with—a conception of disease as alterations in the properties of the solids of the body. Such generalized principles were reorganized in various ways to fit them into a scheme of connected nutritional processes reflecting anatomical advances and experimental discoveries ranging from the Galenic system to the discovery, in the seventeenth century, of the circulation, the lymphatic vessels, and the secretory organs. The materia medica was no longer split into a traditional Galenic system restricted to botanical preparations and a rival Paracelsian repertoire of chemical drugs derived from the mineral kingdom, but the medicaments in use a century after the deep conflicts of the seventeenth century still reflected this dual source.

Eighteenth-century therapeutics is usually described in terms of the doctrines of a few great teachers, including Hermann Boerhaave, Friedrich Hoffmann, Georg Ernst Stahl, William Cullen, and their followers.[4] Beneath the distinctions that marked these figures as leaders of competing schools, however, were certain broad features that link

them as common representatives of the thought and practice of their era.

The most fundamental idea bequeathed by the Hippocratic writers of antiquity to early modern times was that health is a balance between opposing properties, and disease a disproportion between them. That these balances were expressed mainly by the amounts and distributions of the four humors—blood, phlegm, yellow bile, and black bile—had already been compromised in later antiquity by accumulating knowledge of anatomy as well as functional inferences drawn from structural arrangements within the body. By the eighteenth century, balances of the fluids of the body referred largely to the proportions of the substances comprising them, particularly of the blood, or of balances between the proportion of solids and fluids within the body. The concept of balance was also extended, however, to "the state of the solids." Boerhaave, Albrecht von Haller, and Cullen were among those who defined the "simple fiber" as the elementary unit from which the structure of the body was composed. The balance to be maintained was between "laxity and rigidity."[5]

Eighteenth-century medicine also retained from antiquity an intimate connection between nutrition, health, and disease, in which diet was still critical to the maintenance of the body's balances; the effects of different foods and of different medicaments were assimilated into the same explanatory framework.[6] William Cullen began his lectures on the materia medica, in 1761, with the statement that a knowledge of this subject "comprehends a knowledge of all the substances or preparations employed in diet or medicine." Nutrients were the substances "used by mankind in their daily food," and "converted into our fluids and solids, in order to sustain their growth and repair their daily waste,"[7] whereas medicaments were applied on occasion to act against the causes of disease; but there was much overlap in their supposed properties and modes of action.

Eighteenth-century physicians believed, as Galen had believed fifteen centuries earlier, that food is transformed in successive intermediate stages to become blood and then to be assimilated to the solids of the body. These stages were defined by the anatomical structures through which the materials passed: the most prominent being digestion in the stomach, the formation of chyle in the intestine and its passage into the lymphatic vessels, the conversion to blood as the lymph passes through the thoracic duct and into the veins, and the assimilation of the completed nutrient matter to the solids of the body. The decomposition of the tissues and the excretion of the resulting fluids in the urine was often conceived as a final stage in the same series of changes that transformed nutrients into body constituents. By the eighteenth century, these transformations were also interpreted as the conversion of vegetable matter to animal matter, because no deep changes were thought necessary when animals fed on flesh. The process was sometimes referred to, therefore, as "animalization."

The traditional connection between dietary imbalances and disease encouraged

eighteenth-century physicians to interpret illness as a consequence of disruptions of the process just summarized. A longstanding association of some diseases with putrefaction lent itself to an analogy between nutrition and incipient putrefaction. Animal matter being peculiarly subject to putrefaction, the process could easily be imagined to begin within the body if animalization proceeded too far. Other diseases could be attributed to insufficient animalization. Corrections for such tendencies could be effected by altering the diet toward more vegetable, or more animal, nutrients. The scheme was thus another variation on the deeply seated theme of health as the maintenance or restoration of a balance, and disease as an imbalance in either direction from the healthy state.

What was the nature of the transformations that foodstuffs were thought to undergo during nutrition? In the eighteenth century, as in antiquity, the tangible physical differences among food, chyme, chyle, lymph, blood, various secretions, and urine dominated descriptions of the process. From the Hippocratics into the seventeenth century, its underlying nature was interpreted simply by analogy to cooking, as a series of "coctions." The advent of an organized discipline of chemistry during that century provided, however, both a new category of analogies and a set of investigative tools. If these tools did not yet enable a direct examination of nutrition within organisms, they did provide an indirect means to make inferences about it by comparing the compositions of the substances, particularly the fluids, thought to comprise its major stages. When analyzed by the distillation methods traditional in early chemistry, animal matters typically yielded large amounts of a volatile alkali. Plant matters typically yielded acidic substances. As nutrition came to be defined as the conversion of vegetable foodstuffs to the substance of the animal body, therefore, it was natural to seek evidence that "animalization" was a conversion, in successive stages, of an acidic substance to an alkaline one. The Dutch physician Hermann Boerhaave, who was one of the leading chemists of the early eighteenth century as well as its greatest medical teacher, tested this view by examining three fluids—milk (which he took to be very similar to chyle in the thoracic duct), blood, and urine—as representative of an early stage, the midpoint, and the final stage of animal nutrition. None of the fluids was overtly acid or alkaline according to indicator tests. Milk, however, turned sour and became "perfectly acid"; urine gave off volatile alkali in distillation; and blood eventually turned putrid and alkaline. Based on that evidence, Boerhaave inferred that in acquiring an animal nature, nutrients were progressively altered from acidity to neutrality, and from neutrality toward alkalinity, but that they did not normally reach the stage of overt alkalinity within the body.[8]

Variants of that scheme resonated through medical thought in the later-eighteenth century. It had the advantage not only of simplicity but of the fact that the study of acids, bases, and neutral salts was the most progressive and active area within the chemistry of the period.

Much seemed to fit within it, including evidence that the contents of the stomach, site of the earliest stages in the process, was detectably acidic. William Cullen described vegetable food as "acescent" and animal food as "alkalescent." Nutrition was a progressive change from "acescency" to "alkalescency." Health was largely a balance between the "acescent acrimony" that would result from too much vegetable food and the "alkalescent acrimony" that too much animal food could induce.[9] One of the most important dietary questions was *"In what proportion should animal and vegetable be mixed?"*[10]

Medicaments in the arsenal of eighteenth-century physicians were assigned various "virtues." Those that strengthened the solids were called astringents, those that relaxed them were emollients. Those that acted on the fluids were generally classed as evacuants, and divided into emetics, diuretics, cathartics, diaphoretics, and menagoga (emmenagogues), according to the several excretory pathways through which they removed the fluids. Stimulants and sedatives acted on the central nervous system. There were also classes of medicaments, such as demulcents, which were intended to counteract acid or other acrimonies. All of these classes were, in one manner or another, seen to act to restore disturbed balances of one sort or another.[11]

Between 1675 and 1699, chemists of the Academy of Sciences of Paris subjected hundreds of plant materials to distillation analysis, hoping to find differences in their composition that might account for their specific medical virtues. They found instead a "great uniformity" in the composition of all plants.[12] The sense that this massive effort to detect the virtues of plants "by their chemical properties" had failed left a disappointment felt long into the eighteenth century. "From chemical investigation," Cullen declared in 1761, "much has been expected; but it is now known little can be obtained."[13] He and others continued to identify the medicinal qualities of plant matters primarily with such immediately tangible properties as their tastes and odors.

Compared to plant matters, the chemistry of medicaments derived from the mineral kingdom (which had been introduced into the materia medica originally by the Paracelsians) was by the mid-eighteenth century relatively accessible to systematic examination. Knowledge of the properties and reactions of the acids, bases, and neutral salts of which they were composed was systematic and rapidly growing.[14] That does not mean that the relation between the chemical properties and the medical effects of such substances was always clear. Cullen believed, for example, that astringents acted by diminishing the watery substance combined with earths in the animal fibers, but could no more explain on this basis why alum, or copper, iron, and lead salts were powerful astringents than why the vegetable astringents acted as they did.[15] On the other hand, the action of anti-acids in the stomach was susceptible to a convincing chemical explanation. According to Cullen, absorbent earths such as magnesia alba, or "alkalines" such as volatile alkali or calx viva, could overcome the "acid acrimony

[that] takes place when the vegetable aliment retains its acid nature to a morbid degree" because they "destroy acidity by neutralizing it."[16]

To some critical medical spokesmen in the late-eighteenth century, it appeared that the ambition to explain diseases and the actions of medicaments in the body through chemical doctrines was leading physicians into "new errors." Johannn Peter Frank complained in 1789 that "the entire repertoire of medicaments was being subjugated to a single science, namely chemistry"; he feared that drugs that had long proven successful in practice might be discarded as useless if no special properties could be discovered in them through chemical analysis.[17]

Importance of Respiration

The centrality of respiration to life has been obvious from earliest times. Galen recognized this elementary fact in a treatise on the subject, which he began with the question: "What is the use of breathing? That it is not a trifling use is clear from our inability to survive for even the shortest time after it has stopped." He developed an analogy between breathing and the flame of a lamp that reappeared in the seventeenth and eighteenth centuries as an expectation that respiration was similar to combustion.[18] The followers of William Harvey were able to show, between 1660 and 1674, that neither flames nor respiration can continue in an evacuated chamber—that both consume some portion of the air, and that venous blood changes to arterial blood in the lungs, only so long as the latter is supplied with fresh air.[19] For the next seventy-five years, however, little progress was made in further connecting respiration with other internal processes, despite extensive investigations.[20]

So long as air was regarded as a single, elementary substance, breathing could only be viewed primarily as a physical process. The emergence of what soon became known as pneumatic chemistry—that is, the identification of different species of airs and the study of their properties—beginning with Joseph Black's fixed air in the 1750s, therefore, opened up new possibilities for the elucidation of respiration as a chemical transformation. Black himself conjectured that respiration may convert ordinary air to fixed air, releasing heat in the process. When Joseph Priestley began to study new airs in the 1770s, he regularly tested their effects on animals. The nitrous air test that he devised as a measure of the "goodness" of air was, in his view, essentially a measure of its suitability for respiration.[21]

When Lavoisier drew up a plan for an extended study of the processes that fix or release airs, early in 1773, he included from the beginning "the respiration of animals" as one of "the operations by which one can succeed in fixing air." There is not space here to summarize the successive investigations in which Lavoisier gradually developed a comprehensive theory of respiration between 1776 and 1790. It will suffice to remark that, for most of that time, he viewed the slow combustion of carbon, later of carbon and hydrogen, as producing animal heat, and he did not connect the phenomenon more generally to the

overall chemical processes of nutrition. In the "Memoir on Animal Respiration," which he read at the Academy of Sciences in 1790, he made that connection in a way that not only gave his theory of respiration a new dimension but thoroughly transformed the traditional meaning of the nutritional processes. "Animal respiration," Lavoisier wrote,

> is nothing else but a slow combustion of carbon and hydrogen, which takes place in the lungs, and . . . animals that respire are veritable lamps that burn and consume themselves.
>
> In respiration, as in combustion, it is the air of the atmosphere which furnishes the oxygen and the caloric. In respiration it is the blood which furnishes the combustible; and if animals do not regularly replenish through nourishment what they lose by respiration, the lamp will soon lack its oil; and the animals will perish, as a lamp is extinguished when it lacks its combustible.[22]

Further on in his paper, Lavoisier acknowledged that he had no compelling evidence that the combustion occurs in the lungs: it may just as well happen "in the course of the circulation."[23] This unresolved question of the location of the process did not vitiate Lavoisier's fundamental insight into its meaning for the overall state of equilibrium of the animal:

> The animal is, therefore, governed mainly by three types of regulators: respiration, which consumes hydrogen and carbon, and furnishes caloric; digestion, which replenishes through the organs which secrete chyle, that which is lost in the lungs; transpiration, which augments or diminishes according as it is necessary to carry off more or less caloric.[24]

Here was a new vision of the processes of material change in animals as the means to maintain an internal balance. It was far more powerful than the many previous concepts of material balance stretching back to antiquity, not only because it integrated for the first time the gaseous exchanges in the lungs with the processes of nutrition but because it made profound sense for the first time of the rapidity of the nutritional exchanges.

Previously, the daily need for food had been attributed either to replacement for the matter of the body consumed or to the losses due to "insensible transpiration," but there had never been a convincing explanation for the large quantities involved. By making nutrition the source of the fuel for respiration, Lavoisier incorporated that long-recognized process into a dynamic system for which rapid replenishment became no longer a mystery but a natural complement to the rapidity of the respiratory exchanges that continually furnish heat and work.

Since the beginning of his career, Lavoisier had repeatedly sought to demonstrate applications of his scientific discoveries for human welfare. From the earlier stages of development of his theory of respiration he had inferred the need for well-ventilated public buildings as a public health measure. It is not surprising, therefore, that he immediately drew from his broader theory consequences applicable to questions of health and disease.

The intensity of the three mechanisms regulating the animal economy can vary within certain limits, Lavoisier stated, but there are boundaries "beyond which compensations can no longer take place." When these are exceeded, "the state of disease begins." When a person exercises so violently that the carbon and hydrogen expended in the lungs cannot be replaced by reserves supplied from the food, the blood is more and more depleted of its carbon and hydrogen. "That is," he declared, "no doubt the cause of the inflammatory diseases." When, in the contrary case, there is too little exercise, or because of the use of certain foods, or of defects in the organs of nutrition or respiration, "digestion introduces more substances into the blood than respiration can consume, there is established an excess of carbon, or hydrogen, or both, in the mass of the blood." If nature cannot overcome this alteration by accelerating the circulation and respiration, the individual may succumb to such illnesses as "the putrid diseases, the malignant fevers, etc.: a class of diseases whose symptoms are well known, but whose causes are very little known." From those simple reflections, Lavoisier claimed, "One can understand how the art of medicine often consists of letting nature take care of itself, how by [changing] the diet alone it is possible to change the quality of the blood." If one diminished the quantity of carbon and hydrogen in the food, respiration would continue to consume it, so that the blood would lose its excess of these substances.[25]

Habitually restrained about building speculative inferences on the results of his experimental investigations, and distant from the experiences of medical practice, Lavoisier wisely left these ideas as general suggestions, briefly expressed.

Claude Louis Berthollet, the most distinguished of the French chemists who had converted to Lavoisier's side during the debates over Lavoisier's oxygen theory of combustion in the 1780s, was an equally critical thinker. Thoroughly committed to the general structure of Lavoisier's chemistry by the 1790s, Berthollet retained sufficient independence to disagree with one of its central tenets, the doctrine that oxygen is the principle of acidity.

Similarly, Berthollet accepted the essential features of Lavoisier's theory of respiration, while differing over such questions as where the combustion took place. He discussed the subject during a course of chemical lectures that he presented at the newly established École Normale in Paris in 1796. The progressive change in the blood, the nearly uniform distribution of heat throughout the animal body, and the production of effects in succession made it appear to Berthollet "incontestable . . . that the animal heat was not the result of a combustion brought about in the lungs, but of a slow combustion which takes place during the course of the circulation." It was the red corpuscles of the blood, he thought, that absorbed the oxygen and conducted it through the circulation until the affinities of the oxygen caused it to combine with the substances with which it formed carbonic acid. In the lungs the carbonic acid thus formed assumed the gaseous state.[26]

These were prescient views, evidence of a far deeper understanding of internal physiological processes than Lavoisier possessed, and probably reflecting the fact that, unlike Lavoisier, Berthollet had come to chemistry from a medical background. It may have been for similar reasons that Berthollet was willing to discuss, more extensively than Lavoisier had, the medical implications of the respiratory theory. Elaborating on Lavoisier's view that inflammatory diseases might be caused by an "exaggeration of the effects of respiration," Berthollet conjectured that motions of the blood vessels that were too lively could diminish the affinity of the lymph of the blood for the globules, allowing the former to become more fluid so that it spread out into the cellular tissue and formed pus. The suspension of digestion in some inflammations and fevers might lead one to "suspect" that fat deposited in the tissues then reentered the blood to be consumed in respiration, increasing the proportion of hydrogen burned and producing the excess of heat that accompanies these illnesses.[27]

Berthollet acknowledged to his students that in offering these views he had "abandoned myself to conjectures remote from the strict standards which we must bring to bear in the sciences." He did so, he said, because he thought that his ideas might stimulate his listeners to undertake "useful research which could alter them through experiment and observation until they became more conformable to the actions of nature."[28]

Berthollet and Lavoisier were also conforming to the strong tendency of their era to bring all new knowledge that might be pertinent to medical problems quickly to bear on those problems. Like their predecessors, they adapted new chemical and physiological views to existing concepts of health and disease. To identify inflammatory diseases, and putrid and malignant fevers, with excesses or deficiencies of carbon and hydrogen in the blood relative to the rapidity of respiration was yet another version of the many balance theories of disease descended from the humoral pathology of antiquity. Were Lavoisier and his followers merely embarked on the formation of one more in the series of late-eighteenth-century medical systems? Or was Lavoisier's theory of respiration the starting point for a truly scientific understanding of the underlying processes of health and disease? Even while noting the resemblances between their explanations and earlier attempts to explain diseases through current chemical and physiological knowledge, we can sense, perhaps not by hindsight alone, that Lavoisier had provided a theoretical structure whose potential to achieve such ambitions was much greater than anything that had preceded it.

Chemistry and the Art of Healing

Aside from the general explanatory potential of Lavoisier's theory of respiration, the most promising immediate application of the new chemistry to the art of healing appeared to lie in the investigation of the medical properties of oxygen. During the period of the Revolution itself, no one adopted this view more avidly, nor pursued it more persistently,

than Antoine Fourcroy. Even before Lavoisier's oxygen theory had displaced the phlogiston theory among leading chemists in Paris, there was considerable interest in the use of "vital air" (the term then used by Lavoisier to designate the union of oxygen with the fire matter that maintained its elastic state) for therapeutic purposes. Around 1780 "several physicians" who proposed to treat persons suffering from pulmonary phthisis by having them breathe vital air consulted Fourcroy on that subject. During the following years, he observed directly the treatment of eleven cases, and he received reports of nine more from various parts of France. Although in some instances the breathing of vital air seemed at first to confer benefits, afterward the symptoms became more grave. Vital air in such diseases, Fourcroy reported in 1789, only accelerated the progress of the deleterious condition. He convinced himself by experiments on animals that breathing pure vital air accelerates respiration and the movements of the heart and arteries to such an extent as to bring on "a veritable febrile state," explaining why vital air is dangerous in phthisis and other diseases in which heat and motions are already too energetic. He believed, on the other hand, that such treatment might be useful "in all afflictions characterized by sensations of cold and slowness of movement."[29]

More important, in Fourcroy's view, was an effort that he pursued for fifteen years to show that oxygen possessed "energetic medical virtues" in the actions of the many pharmaceutical substances in whose composition it played a part. The initial inspiration for his venture came from a study carried out by Berthollet, at a time when Berthollet still supported the phlogiston theory. In 1779 and 1780, Berthollet had read at the Academy of Sciences a paper on "The Causticity of Metallic Salts." The principal subject of his investigations had been the two salts of mercury, corrosive sublimate and dulcified mercury, long regarded as salts composed of mercury and marine acid in different proportions. The former was notorious as an extremely caustic substance, whereas the latter was very mild. By studying the actions of various acids on these and related substances, Berthollet was able to show convincingly, within the framework of phlogiston theory, that caustic metallic salts are those that actively remove phlogiston from other substances, whereas they become mild once they have combined with the phlogiston.[30]

Berthollet's study exhibited the continuing interplay between chemical and medical questions that was characteristic of much early modern chemistry. Causticity was a property that defined certain classes of chemical substances—including strong acids, alkalis, and earths—a property that appeared or disappeared with regularity in well-defined types of chemical change. It was, however, more fundamentally a property recognized by its physiological and medical effects—by taste, by destructive action on animal matter, and by drastic emetic or other purgative actions when taken internally. In his paper, Berthollet described a set of investigations ostensibly chemical in nature but sprinkled with allusions to medical matters. Of a white precipitate

of mercury whose chemical preparation indicated that it "contains a portion of phlogiston which takes away a part of the causticity of calomel," he commented that it nevertheless contained less phlogiston than dulcified mercury, "and, in fact, if one gives rather strong doses of it, it stimulates vomiting."[31]

After Fourcroy converted, in 1784, to Lavoisier's views, it appeared obvious to him that the properties of corrosive sublimate that Berthollet had attributed to its "avidity to remove phlogiston from animal matter" belonged instead "to oxygen, whose action must take place in the inverse manner." In that year, he began to teach in his course and to demonstrate by experiments that caustic metallic substances, such as the oxide of arsenic and the red oxide of mercury, "literally burn animal substances": that is, they cede their oxygen to the substances, being thereby reduced to the metallic state. "Pushing these ideas further," he began in 1785 and 1786 to show "that the actions of various medicaments may well derive from the oxygen contained in their composition." Many metals and other combustibles that had no action, or only feeble actions on animals in this state, he found, when combined with oxygen, took on the properties of "purgatives, emetics, even corrosives, in proportion to the oxygen that was combined with them in the diverse pharmaceutical preparations" made with them.[32]

Temporarily set back by the objection that water, "the most oxygenated of all substances," is medically inactive, Fourcroy responded resourcefully by posing a "second principle," that oxygenated substances exert sensible effects on our bodies only to the extent that they "abandon [their oxygen] more or less easily to the animal materials with which they come into contact." Now he found abundant evidence of the correctness of his insight. The application of caustic metals such as muriate of antimony, known traditionally as butter of antimony (and, according to Cullen, "one of the most corrosive substances we can apply to the body, and only used in . . . this form externally"[33]) left little doubt that their effects were attributable to the reduction of their oxides and "the passage of their oxygen to the animal matter." Multiple similar examples persuaded Fourcroy that he had established "a general doctrine of the function or medical force of oxygen." Henceforth he hoped to devote his attention to "the mode of action" of the oxygen.[34]

An accident that befell two workers in his laboratory in 1787 while they were preparing the recently discovered oxygenated muriatic acid afforded Fourcroy his first opportunity to pursue this quest. Having obtained a large quantity of the acid in gaseous form, without taking proper precautions, the young men were seized with violent coughing and suffocation. They rendered up matter resembling egg white, their palates felt hard and dry, their tears and mucus were thickened, and their symptoms in general resembled those of a violent cold. To ascertain the actions of this potent gas with greater "precision," Fourcroy impregnated egg albumen, blood serum, and saliva with it. Not only did he observe constantly that the fluids were thickened, solidified, or coagulated, but

the oxygenated muriatic acid was reduced to the state of ordinary muriatic acid.[35]

Cognizant that he had made a crucial advance, Fourcroy began in 1789 to "execute a plan of work" in which he would systematically investigate the actions on animal substances of substances that would cede oxygen to them. Perhaps distracted by other concerns during the Revolutionary period, Fourcroy did not make as much progress in this research as he had hoped, yet he did find further evidence for his view in such phenomena as the thickening of nasal mucus, tears, and saliva under the influence of atmospheric oxygen. Altogether, he perceived that, these effects led one back to the phenomenon first recorded by the Hippocratic physicians and "confirmed by the observations of all the centuries and practitioners of the art" of medicine since then: the critical change called by the ancients "coction," in which the thickening of humors and discharges presaged the favorable outcome of a disease. He could now recognize that coction was nothing else than the fixation of oxygen, by combinations analogous to those he had demonstrated in animal matters outside the body.[36]

Seeking to turn his discoveries to useful application, Fourcroy tested, together with his friend, the well-known Parisian physician Jean-Noël Hallé, the effects of oxygenated muriatic acid on fetid cancers. In the case of a woman with a large breast cancer, treatment of an ulcer with the acid liquid brought some improvement, but its duration was short. Following a suggestion that Fourcroy made in his course in 1790, two physicians treated syphilitic patients with oxygenated muriatic acid and noted some improvement in their condition. In the same year Fourcroy announced, on the basis of his own experiments, that oxygenated muriatic acid destroys putrid miasmas and that it could be employed as a disinfectant. His recommendation that oxygenated muriatic acid be substituted for mercury in military hospitals for the treatment of syphilis and other skin diseases was rejected by conservative public health officers, but he remained persuaded that if he continued to spread his ideas through his public courses, they would "gradually take root in the minds of students, and would obtain there the reception and support which alone could give them the usefulness of which I believe them to be susceptible."[37]

Application of the New Chemistry

As the strong resistance to Lavoisier's chemistry by defenders of phlogiston chemistry in Germany and in Great Britain waned in the years after 1790, interest in its medical applications began to appear there too. Christoph Girtanner, a student of chemistry, practitioner of medicine, and free-lance writer in Göttingen, exuberantly promulgated a medical system that featured oxygen as "the principle of irritability." Returning from a trip through Scotland, London, and Paris in 1790, Girtanner began to translate the new nomenclature of French chemistry into German, wrote essays criticizing the phlogiston theory, and worked on a textbook called *First Principles of Antiphlogistic Chemistry,* intended to introduce Lavoisier's chem-

istry systematically in the German language.[38] Meanwhile, he published in French, in the *Journal de Physique* (a publication not generally friendly to the new chemistry) two articles setting forth the ideas that he believed would reduce "the whole art of medicine" to a simple calculation of the value of x in the equation x=ab, where a=the intensity of the stimulus to a body fiber, b=the degree of irritability of the fiber, and x=the stimulus required to restore the normal tone of the fiber.[39]

Girtanner's physiological and pathological ideas, based ostensibly on Albrecht von Haller's discovery of the irritability of the muscle fiber, were so similar to those of John Brown that he has sometimes been accused of plagiarizing the Scottish physician whose medical system was then sweeping across Europe.[40] Like Brown, Girtanner reduced all health and disease to the "degree of irritability of the solids and fluids" of the body. Girtanner differed from Brown by invoking oxygen as the agent to whose presence "in all parts of the system was due the irritability and the life of the organized body." He believed that he had proven that the degree of irritability in any part of the body "is always in proportion to the quantity of oxygen."[41]

Girtanner based his scheme on Lavoisier's theory of respiration, suitably modified to fit his needs. Although he accepted the view, maintained particularly by Lavoisier's younger associate Armand Seguin, that a hydro-carbonaceous substance contained in the venous blood is burned by some of the inspired oxygen to carbonic acid and water in the lungs, Girtanner argued that another portion of the oxygen is absorbed into the blood. Through a series of experiments on samples of arterial and venous blood exposed variously to oxygen, hydrogen, carbonic acid, and nitrogen gas, Girtanner satisfied himself that he had proven "in a decisive manner the presence of oxygen in arterial blood." That done, he could infer with confidence: "The blood which is oxygenated during its passage through the lungs is deprived of its oxygen during the circulation, the oxygen having a greater attraction for the irritable fiber than for the carbon contained in the blood." Health and disease, therefore, hung on the degree of stimulation received by the irritable fibers in their interactions with the blood. If circulation became too rapid, the result would be a fever, the type and intensity depending on the degree to which "the circulation becomes more rapid, the blood absorbs more oxygen, and overcharges the whole system."[42]

Girtanner's explanation for febrile diseases immediately suggested methods by which one could prevent these bad effects of overstimulus: (1) "prevent the blood from being overcharged with oxygen by reducing the proportion of the oxygen gas in the air that the patient respires"; (2) apply stimulating medications such as wine, opium, or heat, which exhaust the irritability of the system; or (3) bleed to reduce the quantity of blood and hence diminish the action of the oxygen contained in the blood on the fibers.[43]

Girtanner inferred, as Fourcroy had, that the actions of many poisons and

medicaments—including oxygenated muriatic acid and the salts of arsenic, mercury, and other metals—depended upon the action of the oxygen they contained on the organic fibers.[44] Girtanner's views spread not only through Germany but as far as England, where they received a clinical test in a military hospital near London. At the Royal Military Academy the Scottish-born anatomist William Cruikshank gave a series of chemical lectures in which he espoused "the new system" of Lavoisier. Among his listeners was John Rollo, Surgeon-General of the Royal Artillery Hospital at Woolwich, who had successfully treated diabetics by placing them on meat diets to reduce the formation of sugar. Rollo was inspired by Cruikshank's lectures to "apply the new [chemical] doctrine to medicine and surgery."[45]

Aware of Girtanner's opinion that "the effects of mercurial preparations were due entirely to the oxygen combined in them," Rollo believed that the German had not proven his assertion "by substituting for mercury in the treatment of venereal disease other substances containing large quantities of oxygen." A report from a surgeon in Bombay named William Scoot, that nitrous acid used in the treatment of liver disease had effects strikingly similar to those of mercury, encouraged Rollo to test that oxygenated substance on patients in the military hospital suffering from the primary symptoms of venereal disease. Cruikshank advised him to include also citric acid, oxygenated muriatic acid, and oxygenated muriate of potash, compounds "which cede their oxygen easily and rapidly."

During the year 1797 Rollo treated seventeen cases, segregated in a special ward of the hospital, with one or the other of these substances. Each of them cured the symptoms of primary syphilis without causing the deleterious side-effects, such as excessive salivation, for which mercury was notorious. Of the substances tried, he found that oxygenated muriate of potash acted most promptly and reliably. Rollo reported his results in the second part of his treatise on diabetes mellitus, where he gave arguments for concluding that the action of all of the substances depended on the release of the oxygen they contained, and speculated on how that action might destroy the syphilitic virus.

Chemistry and Syphilis

Meanwhile, in Paris the ideas planted so insistently by Fourcroy in the minds of those who followed his course lectures, began, in one of them, to bear abundant fruit. Pierre-Philippe Alyon, physician and tutor to the children of the Duke of Orléans, had begun in 1782 a crusade to banish the treatment of syphilis with mercury, to find the true theory of venereal disease, and to devise a rational cure. At the same time he was attending the lectures of Fourcroy, who gave him encouragement in his endeavor and helped him edit a paper on the subject that Alyon delivered at the Royal Society of Medicine in 1783. During a stay in England, he received further encouragement. Circumstances conspired, however, to slow his progress.

After the death of his patron during the Revolutionary period, he was imprisoned for several months; then for five years, he was frequently displaced while he served as a health officer in military hospitals. Nothing could deter him permanently, however, from pursuing his goal.[46]

An early convert to the chemistry of Lavoisier, Alyon had written in 1787 an elementary textbook of chemistry for children, in which he used the new nomenclature devised by Lavoisier and his associates. Not surprisingly, with the continued support of Fourcroy, Alyon sought during the 1790s cures for syphilis "obtained by combinations of oxygen."[47] Following up a suggestion by Fourcroy that a mercurial ointment used in the treatment of venereal ulcers and other skin eruptions owed its properties to the oxygen derived from the oxide of mercury it contained, Alyon searched for ways to compose an oxygenated ointment without the mercury. He succeeded by melting a mixture of lard and nitric acid. After numerous trials he was able to carry out the operation under conditions such that the nitric acid decomposed, its oxygen combining with the lard, leaving the azote to escape as a gas. The resulting "oxygenated pomade" possessed remarkable medicinal properties. Readily depositing its oxygen on the animal tissues on which it was rubbed, it healed not only venereal ulcers but psoriasis, scabies, and other skin eruptions.[48]

The facility with which nitric acid had given up its oxygen to the lard in the chemical operations through which he had produced his pomade led Alyon to predict that it would also deposit oxygen easily "in the animal economy." It might therefore be administered internally as an anti-venereal drug. As the public health officer at the military hospital of Val-de-Grâce, he was in a position to test his hypothesis clinically, after having assured himself by drinking a *gros* (approximately 3.8 grams) of the acid diluted in a pint of water, daily for a month, that it was not harmful. Within a space of eight months he administered nitric acid to more than 150 patients with venereal diseases. "The effects of nitric acid are not always the same in all subjects," he reported. Sometimes it "makes the most serious symptoms disappear within a very short space of time, whereas in other circumstances its action is much less marked and much slower." He regarded his trials as successful enough, however, to advocate that health officers make use of nitric acid.[49]

Alyon, too, offered a theory of the action of oxygen in the animal economy, and of its action on the syphilitic virus. The nature of the virus itself remained unknown: Alyon thought it might act directly on the parts of the body that it disorganizes, or indirectly, as a poison, causing secondary symptoms far from the virus itself. In any case, Alyon agreed with the Brunonian view that the symptoms of syphilis are all debilitating illnesses, and that the successful remedies were stimulants that helped the vital force to overcome the virus. Anti-venereal drugs act by releasing oxygen, which "stimulates the viscera, irritates them more or less, augments the contractions of the heart, elevates the pulse,"

and increases the secretions so that the action of the virus, tending always to weaken the system, is nullified.[50]

According to his own testimony, Alyon encountered much opposition to his views, being forced repeatedly to defend himself from accusations that his oxygenated pomade was either ineffective or unoriginal. Resolute, he continued to press his campaign. In more than fifteen military hospitals he documented his claims concerning the abuses practiced in the continued use of mercury. The military committee of the Convention of the Republic called on all public health officers for advice on the best method to cure scabies and venereal disease, but the results brought no change. Alyon asked the Minister of the Interior for authorization to conduct comparative clinical trials of his new method of treatment and the customary mercurial ones, to be witnessed by leading practitioners. When the minister acceded to this request, the Faculty of Medicine appointed commissioners to follow the treatments. To further his campaign, Alyon published in 1797 a treatise in which he sought to convince his colleagues of the validity of his position. It included, in addition to the arguments outlined here, twenty-seven case histories documenting the effectiveness of his oxygenated pomade.[51]

Chemistry and Pathology

At the end of a century sometimes called by historians of medicine "The age of theories and systems,"[52] we might well expect the new chemistry to spawn its own medical system. The boldest effort to construct such a system came from a professor of medicine at Montpellier, Jean-Baptiste-Timothée Baumes. After establishing an extensive practice at Nimes, where he also wrote prolifically about particular diseases, work for which he received prizes from both the Faculty of Medicine and the Royal Society of Medicine of Paris, Baumes was awarded a chair in medicine at Montpellier in 1790, after giving a "brilliant concurs." During the next few years he began his course in nosology with a discourse advocating an alliance between pneumatic chemistry and medicine.[53] In 1798 he published his new "doctrine" in the form of an *Essay on a Chemical System of the Science of Man*.

Attached to principles "which it believes immutable because they have descended from the school of Cos," Baumes began, medicine would appear resistant to "renewal by the new system of modern chemistry." Nevertheless, pneumatic chemistry and medicine shared the same commitment to rely on facts alone. The facts that medicine observed—the symptoms that characterize diseases—were limited to surface signs that were often illusory. The chemist, "replacing supposition by calculation," could offer both successful analyses of morbific products and illuminating applications of his general results. "Medicine must naturally be a tributary . . . of that modern analytical, experimental chemistry which, by grace of the genius of Lavoisier, . . . covers with its luster the arts which depend on it, and the sciences to which it gives its support."[54]

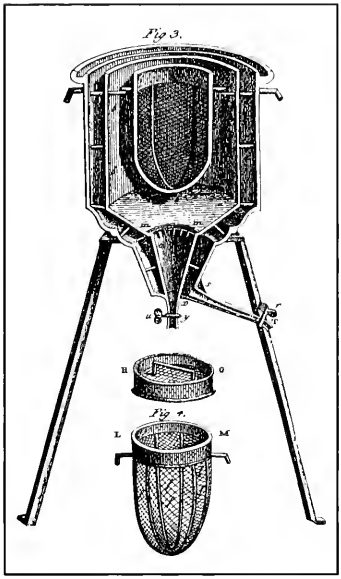
Baumes divided his essay into three parts: physiological chemistry, patho-

logical chemistry, and therapeutic and pharmaceutical chemistry. His physiological chemistry, a compendium of contemporary views, drew particularly on Lavoisier's theory of respiration as rendered by Berthollet and Girtanner, on Fourcroy's analyses of the composition of the fluids and solids of the body and his interpretation of digestion, and on a reinterpretation of animalization in the language of the new chemistry. The latter was based on Berthollet's demonstration that the volatile alkali long thought to characterize animal matter derived from nitrogen, and that the characteristic "animal matters" identified by Fourcroy—fibrin, albumin, and gelatin—were composed mainly of carbon, hydrogen, oxygen, and nitrogen. Although some plant matter also contained nitrogen, on the whole animal matter yielded much more of it, leading Fourcroy to conclude in 1789 that the conversion of food to the substances of the animal body must consist of the addition of nitrogen to plant matter. In 1791 Fourcroy's friend Jean-Noël Hallé published a scheme depicting animalization as a conversion of plant to animal matter in three stages, in each of which nitrogen was added while carbon was removed by combining with oxygen. The third stage took place in the lungs, thus connecting animalization with respiration as defined by Lavoisier.[55]

Baumes outlined a similar scheme, linked it with the older views of animalization by associating highly nitrogenous substances with "alkalescence," highly carbonaceous ones with "ascescence," and excessive animalization with disease. "In that succession of chemical and vital processes," he wrote,

> not only does the chyle, losing a part of its carbon, receive in its place nitrogen from the blood, and by this mechanism become animalized and assimilated; but in addition the blood receives a kind of assimilation, because, without that exchange it would become too animalized, and end up becoming alkaline. The latter is a concern for pathological chemistry.[56]

It was in the application of this chemistry to pathology that Baumes claimed to be opening up an "absolutely new



The calorimeter that Antoine-Laurent Lavoisier and Pierre-Simon de Laplace used to measure the relative amounts of heat evolved in chemical reactions. Their experiments led them to infer that respiration is a kind of combustion, and that body heat is maintained by the production of "fixed air" in the lungs. From Plate 6 in Antoine-Laurent Lavoisier, Elements of Chemistry, *trans. Robert Kerr (Edinburgh, 1790).*

pathway." All disorders of our functions, he declared, can be related to oxygenation, calorification, hydrogenation, nitrogenation, and phosphorylation. Consequently, there are "five great classes of diseases: oxygeneses, calorineses, hydrogeneses, nitrogeneses, and phosphoreneses."[57]

Comparing his view of the first class of diseases, disorders of oxygenation, to those of Girtanner, Rollo, and others, Baumes speculated at greater length on the various affections, such as spasms, scurvy, scrofula, rickets, and chlorosis, that he attributed either to over- or under-oxygenation. The various remedies he discussed were all intended to "restore to the system the equilibrium which it had lost by the addition or subtraction of the principles which make up the animal compounds." Diseases due to disorders of calorification were closely related to those of oxygenation because both were effects of respiration as accounted for in the theory of Lavoisier (and in Adair Crawford's theories of animal heat, which contemporaries often associated with those of Lavoisier despite major differences).[58] Treatments were, however, aimed more directly at counteracting excessive heat by cooling the body, and the inverse.[59]

Baumes ascribed "hydrogeneses," of which bilious and intermittent fevers were prime examples, to an overabundance in the body of such carbonated hydrogen compounds as the oily substances of the bile. The most common cause, he thought, was the action in the lungs of hydrocarbonaceous gas, associated with swampy lands. Their prevention called for rigorous avoidance of foods that "can furnish carbonated hydrogen," including animal fat, butter, and cheese. Disorders due to over-nitrogenation—such as putrid fevers, dysenteric fevers, and advanced scurvy—were, according to Baumes, the consequences of too much animalization, resulting in alkalescent blood and body fluids. The most active remedies were acids, vegetable substances, wine, and cinchona, which "oxygenate the system, prevent the development of nitrogen, and prevent the deleterious products of putrefaction."[60]

The new chemistry would produce a new therapeutics and a new pharmaceutical chemistry, Baumes predicted, as the remedies in the materia medica became reorganized into oxygans, calorans, hydrogans, nitrogans, and phosphorans. Among those of the first class he mentioned Rollo's suroxygans and disoxygans as well as an oxygenated fat that he did not associate with Alyon.[61]

Baumes acclaimed his medical system as not only the way by which chemistry would "render the most remarkable service to medicine" but as a synthesis of the new knowledge with the best in competing older medical systems. "This application," he wrote, "will revive the humoral pathology of which Boerhaave was the great defender, combined to a certain point with that of the irritable fiber introduced by Hoffman, Cullen, Brown, Darwin, and supported by the great physicians of the Montpellier school." The "new chemistry," he continued, was "favored by those who honor facts, the theories which arise from them, and systems which appear to be based on the truth." He trusted that

his application of chemistry to pathology would not be "admitted without reflection, but at least examined without prejudice."[62]

Reaction to the New Chemistry

By the last years of the century, Antoine Fourcroy viewed with deep ambivalence the proliferating efforts to apply the new chemistry to medicine. On the one hand, having called for such applications for many years, he saw the rapidly spreading interest as a response to what he had so persistently advocated. On the other hand, he believed that some of those who were now crowding into the picture both ignored his own pioneering role and applied unproven general schemes too hastily to complex problems. Particularly annoying to him was the attention paid to what his protégé Alyon called the "reveries" of Girtanner, and others of that ilk.[63] By 1797 Fourcroy began to speak out in protest. In a letter to an editor of the *Annales de Chimie* (the journal of the new French chemistry), he expressed his fear that if chemists continued to press too many hypotheses about the animal economy, supported by too few experiments, "physicians may well raise a cry against "this *encroachment* of chemistry. If one hurries the applications too much, if one heaps up arbitrary suppositions, it may happen that chemistry will once again be rejected from the art of healing."[64]

Distinguishing himself from those, such as Girtanner, who had "allowed themselves to be carried away by the ingenious ideas that chemistry furnishes them," Fourcroy avowed that he saw himself as "still on the journey, and far from the place where I am trying to go." Young men follow his course on animal chemistry at the faculty of medicine "with ardor," he boasted. He saw in their intense interest in the subject a grand movement, but he was careful to moderate its velocity.

> I do not want to accelerate it, for fear of breaking that beautiful machine in my hands. It would be a great shame to see such rich and fortunate hopes disappear in smoke. That will not fail to happen if one builds an edifice on hypotheses, and rushes too much to construct, when one does not yet have enough material.[65]

Fourcroy had composed the letter in response to one from Alexander Humboldt to the *Annales* editor containing some applications of chemistry to experiments on muscle irritability that Fourcroy considered too hypothetical.[66] When Humboldt wrote Fourcroy, asserting that his ideas were not the work of a few months but the result of experiments that had occupied him for four years,[67] Fourcroy responded with a second letter assuring Humboldt that his remarks about "the exaggerated ideas that some modern physicians wish to introduce into medicine" were aimed neither at Humboldt's "ingenious experiments, nor at their useful results." As an example of the kind of "premature application" against which he warned, Fourcroy mentioned "the diseases newly classified by excess of hydrogen [or] oxygen, and the remedies confined to the genres of oxidants or deoxidants,

with which some moderns are already attempting to reconstruct the whole art of healing."[68]

Fourcroy recognized that clinical studies such as those of John Rollo or of his own student Alyon were of more permanent value. Here his ambivalence derived from the failure of those outside Paris to recognize his germinal achievements in the field. To make them clear, he appended a series of long footnotes to a French translation by Alyon of Rollo's treatise on diabetes. "Rollo appears to attribute to D. Girtanner," Fourcroy wrote, "the first idea attributing the action of mercurials to the oxygen they contain." He reminded readers, therefore, that:

> the theory of the medical action of oxygen is due entirely to the French school, and that long before M. Girtanner had spread the first ideas about that in Germany, citizen Berthollet and I had developed and made them public in France, both in our public courses and our writings.[69]

Conclusion

From our distant vantage point late in the twentieth century, it may appear that Fourcroy was protesting too much. If he thought that Baumes, Girtanner, and other unnamed physicians were erecting hollow systems while he patiently gathered facts from the analysis of animal matter, to us they may seem to have been only by degree hastier or bolder than he was. Fourcroy can readily appear to our age as a leader—not in the prudent exploration of the chemical foundations for a reformed art of healing, as he saw himself, but in the premature application of the chemical theory of oxygenation to therapeutics. The priority for which he sought the acknowledgment of his contemporaries might be seen two hundred years later as credit only for being one of the first to apply the chemistry of Lavoisier too eagerly, with ideas about physiological processes that were too simple, to traditional definitions of disease that were too inadequate.

Such judgments are easy, but unfair. The proponents of the application of the new chemistry consolidated around Lavoisier had every reason to believe that they possessed the means to achieve fundamental reforms in the theory and practice of medicine. Chemistry and medicine had long been so closely associated that a revolutionary advance in the former would seem immediately pertinent to the latter. Moreover, Lavoisier's theory of respiration, so closely connected with the theory of combustion at the heart of the new chemistry, provided the deepest insight that chemistry had ever offered into the meaning of the material exchanges of the human body. What could be more natural than to infer that this insight extended to pathological as well as physiological processes? The need to apply whatever new insights science could make available to improve treatments for such devastating diseases as syphilis was extremely urgent, as it always is. The pressure to do so was particularly acute during the Revolutionary wars, when large armies were maintained in Europe, venereal disease was rampant among them, and military physicians and surgeons had ample au-

thority to experiment boldly. In France, openness to medical reform was also enhanced by the radical changes already brought through political revolution.

If, in responding to all these pressures and opportunities, those who tried, during the period of the chemical revolution, to draw from it new methods for understanding and treating illness, strongly underestimated the difficulty of the problems they faced; if the complexity of the phenomena they sought to control far exceeded what they could imagine, they were not, in that regard unlike their successors down to our own time. The physiology, biochemistry, and pathology of the human body have, in every era of history, including our own, proven more complex than predicted by current scientific theory. Scientists and physicians have always had, and still have, an inevitable need to simplify nature in order to cope with it. Like our predecessors, we are locked in a perpetual struggle between the limits of our technical means and cognitive capacities, and the boundless complexity of the world in which we must act.[70]

Notes

1. Nicolas Lemery, *Cours de Chymie,* 4th ed. (Paris: Chez l'Author, 1681), aij–aiij, 2.

2. For echoes of this view, see Sir Alexander Todd, "Introduction," and Douglas McKie, "Chemistry in the Service of Medicine: 1660–1800," in *Chemistry in the Service of Medicine,* ed. F. N. Poynter (Philadelphia: J. B. Lippincott, 1963), 1–4, 43–54, esp. 47.

3. Antoine Fourcroy, "Sur l'application de la chimie pneumatique à l'art de guérir, et sur les propriétés médicamenteuses des substances oxigénées," *Annales de Chimie* 28 (1799): 231.

4. For a succinct general treatment, see Erwin H. Ackerknecht, *Therapie: Von den Primitiven bis zum 20. Jahrhundert* (Stuttgart: Ferdinand Enke, 1970), 78–94. Accessible summaries of the views of these and other prominent eighteenth-century medical teachers are given in Lester S. King, *The Medical World of the Eighteenth Century* (Chicago: University of Chicago Press, 1958), esp. 59–93, 123–55, 193–226. For more recent discussions of the roles of these figures, see the following essays in *The Medical Enlightenment of the Eighteenth Century,* ed. Andrew Cunningham and Roger French (Cambridge, Eng.: Cambridge University Press, 1990): Andrew Cunningham, "Medicine to Calm the Mind: Boerhaave's Medical System, and Why It Was Adopted in Edinburgh," 40–66; Johanna Geyer-Kordesch, "Georg Ernst Stahl's Radical Pietist Medicine and Its Influence on the German Enlightenment," 67–87; and Roger French, "Sickness and the Soul: Stahl, Hoffmann and Sauvages on Pathology," 88–110.

5. William Cullen, *Lectures on the Materia Medica,* 2d ed. (Dublin: Whitestone, 1781), 1–13.

6. See Owsei Temkin, "Nutrition from Classical Antiquity to the Baroque," in *Human Nutrition: Historic and Scientific,* ed. Iago Galdston (New York: International Universities Press, 1960), 78–97.

7. Ibid., 1, 37.

8. Hermann Boerhaave, *A New Method of Chemistry,* trans. Peter Shaw, 2d ed., 2 vols. (London: T. Longman, 1741), 2:185–205. See also F. R. Jevons, "Boerhaave's

Biochemistry," *Medical History* 6 (1962): 348–56; and F. W. Gibbs, "Boerhaave and the Place of Chemistry in Medicine," in *Chemistry in the Service of Medicine,* 27–54.

9. Cullen, *Lectures,* 37–126.

10. Ibid., 85.

11. Ibid., 26–37.

12. See Frederic L. Holmes, *Eighteenth-Century Chemistry as an Investigative Enterprise* (Berkeley: Office for History of Science and Technology, 1989), 63–65.

13. Cullen, *Lectures,* 140.

14. Holmes, *Eighteenth-Century Chemistry,* 33–55.

15. Cullen, *Lectures,* 143–84.

16. Ibid., 360–65.

17. Johann Peter Frank, *Kleine Schriften praktischen Inhalts* (Vienna: Schmidbauer, 1797), 227, 229.

18. Galen, "On the Use of Breathing," in David J. Furley and J. S. Wilkie, *Galen on Respiration and the Arteries* (Princeton: Princeton University Press, 1984), 81–133.

19. Leonard G. Wilson, "The Transformation of Ancient Concepts of Respiration in the Seventeenth Century," *Isis* 51 (1959): 161–72; Robert G. Frank, *Harvey and the Oxford Physiologists* (Berkeley: University of California Press, 1980).

20. Diana Long Hall, *Why Do Animals Breathe?* (New York: Arno, 1981).

21. For a detailed description of the developments mentioned in this and the following paragraph, see Frederic L. Holmes, *Lavoisier and the Chemistry of Life* (Madison: University of Wisconsin Press, 1985). Priestley's nitrous air test also gave rise to "eudiometric" methods for measuring the "virtue" of airs, which became in turn the foundation for a campaign to establish a "pneumatic medicine" based on quantitative tests of the healthiness of the air. See Simon Schaffer, "Measuring Virtue: Eudiometry, Enlightenment and Pneumatic Medicine," in *Medical Enlightenment,* 281–318.

22. Armand Seguin and Antoine Lavoisier, "Premier mémoire sur la respiration des animaux," *Histoire de l'Académie des Sciences,* 1789 [1793], 570.

23. Ibid., 583.

24. Ibid., 580.

25. Ibid., 580–82.

26. *Séances des Écoles Normales,* nouvelle ed., 3 vols. (Paris: De l'Imprimerie du Cercle-Social, 1796), 3:370–71.

27. Ibid., 3:375–76.

28. Ibid., 3:377.

29. Fourcroy, "Extrait d'un mémoire sur les propriétés médicinales de l'air vital," *Annales de Chimie* 4 (1796): 83–93.

30. Fourcroy, "Sur l'application de la chimie pneumatique à l'art de guérir, et sur les propriétés médicamenteuses des substances oxigénées," *Annales de Chimie* 28 (1799): 225–79; C.-L. Berthollet, "Essai sur la causticité des sels métalliques," *Mémoires de l'Académie Royal des Sciences,* 1780 [1784], 448–70.

31. Berthollet, "Essai sur la causticité des sels métalliques," 458.

32. Fourcroy, "Sur l'application de la chimie pneumatique," 242–45.

33. Cullen, *Lectures,* 402.

34. Fourcroy, "Sur l'application de la chimie pneumatique," 244–54.

35. Ibid., 256–59.

36. Ibid., 259–63.

37. Ibid., 268–78.

38. Karl Hufbauer, *The Formation of the German Chemical Community (1720–1795)* (Berkeley: University of California Press, 1982), 100–44, 208–9; Christoph Girtanner, *Anfangsgründe der antiphlogistischen Chemie,* 3d ed. (Vienna: n.p., 1801).

39. C. Girtanner, "Sur l'Irritabilité, considerée comme principe de la vie, dans la nature organisée. Premier Mémoire," *Observations sur la Physique* 36 (1790): 432–33.

40. For a collection of recent scholarship on John Brown and the impact of his medical system, see W. F. Bynum and Roy Porter, eds., *Brunonianism in Britain and Europe,* supp. 8 of *Medical History* (London: Wellcome Institute for the History of Medicine, 1988).

41. Girtanner, "Sur l'Irritabilité . . . Premier Mémoire," 422–40; Girtanner, "Sur l'Irritabilité . . . Second Mémoire," *Observations sur la Physique* 37 (1790): 139, 147.

42. Girtanner, "Sur l'Irritabilité . . . Premier Mémoire," 437; Girtanner, "Sur l'Irritabilité . . . Second Mémoire," 139–54.

43. Girtanner, "Sur l'Irritabilité . . . Premier Mémoire," 438.

44. Girtanner, "Sur l'Irritabilité . . . Second Mémoire," 151.

45. John Rollo, *Traité du diabete sucré,* trans. P. P. Alyon, 2 pts. in 1 vol. (Paris: Moutardier, 1797), pt. 2:ii–iii, 12–13; G. T. B., "Cruikshank, William," *Dictionary of National Biography,* vol. 5 (London: Macmillan, 1908), 260–61; N. M., "Rollo, John," *Dictionary of National Biography,* vol. 17 (London: Macmillan, 1909), 169–70.

46. P. P. Alyon, *Essai sur les propriétés médicinales de l'oxygène* (Paris: Cerioux, 1797), 1–12; "Alyon, Pierre-Philippe," in Dezeimeris, Ollivier, and Raige-Delorme, *Dictionnaire historique de la médecine ancienne et moderne,* 4 vols. (Paris: Béchet, 1828), 1:104–5.

47. Alyon, *Essai,* 5, 40; "Alyon," 105.

48. Alyon, *Essai,* 44–55.

49. Ibid., 55–64. A *gros* was a pre-metric-system French weight.

50. Ibid., 138–59.

51. Ibid., 5–12.

52. Fielding H. Garrison, *An Introduction to the History of Medicine,* 4th ed. (Philadelphia: W. B. Saunders, 1929), 310. The leading systems are clearly summarized in King, *Medical World.* For a newer view of the meaning of medical systems in the eighteenth century, see Christopher Lawrence, "Ornate Physicians and Learned Artisans: Edinburgh Medical Men, 1726–1776," in *William Hunter and the Eighteenth-Century Medical World,* ed. W. F. Bynum and Roy Porter (Cambridge, Eng.: Cambridge University Press, 1985), 153–76.

53. E. Gurlt, "Baumes, Jean-Baptiste-Timothée," in *Biographisches Lexikon der hervorragenden Ärzte,* ed. August Hirsch, 5 vols. (Berlin: Urban and Schwarzenberg, 1929), 1:386–87.

54. J. B. T. Baumes, *Essai d'un système chimique de la science de l'homme* (Nismes: Guibert, 1798), 5–7.

55. Ibid., 9–32; Frederic L. Holmes, "Elementary Analysis and the Origins of Physiological Chemistry," *Isis* 54 (1963): 61.

56. Baumes, *Essai,* 33.

57. Ibid., 47–48.

58. See Everett Mendelsohn, *Heat and Life: The Development of the Theory of Animal Heat* (Cambridge, Mass.: Harvard University Press, 1964), 123–65.

59. Baumes, *Essai,* 48–65.

60. Ibid., 65–80.

61. Ibid., 89–99.

62. Ibid., 47, 89.

63. Alyon, *Essai,* 40.

64. "Extrait d'une lettre du citoyen Fourcroy, au citoyen Van Mons, au sujet de celle de M. Humboldt," *Annales de Chimie* 22 (1797): 77–78.

65. Ibid., 78–80.

66. "Lettre de M. Von Humboldt à M. Van-Mons, sur le procédé chimique de la vitalité," ibid., 64–76.

67. "Lettre de Fréderic Humboldt au C. Fourcroy," *Annales de Chimie* 27 (1798): 62–66.

68. "Réponse du citoyen Fourcroy à M. Fréderic Humboldt," ibid. 67–71.

69. Rollo, *Traité,* pt. 2:138.

70. John Harley Warner, who kindly read this manuscript and made many valuable suggestions, only some of which I have been able to incorporate into the present

format, has pointed out that the applications of chemical ideas to medicine described here were characteristically presented in pedagogocal settings, and that the need to simplify nature is urgent also when teachers and students confront the task of mastering a huge body of knowledge. Warner to Holmes, personal communication, May 21, 1995. The extent to which the "new chemistry" of Lavoisier penetrated into medical lectures beyond those of the immediate promoters of these doctrines is an inviting subject for further exploration.

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Pathology and Treatment: The Case of Ulcers

If you want to understand disease, open up a few corpses, advised the French physician Xavier Bichat at the beginning of the nineteenth century.[1] Examining the body at autopsy provided nineteenth-century doctors with a powerful means for classifying and understanding disease. But early in the century doctors offered no practical connections between their treatment of disease and the new and growing science of anatomical pathology. After all, therapeutics was the treatment of the living patient, and pathology the study of the dead. Both therapeutics and pathology offered useful approaches to the problem of disease, but the connections between these approaches in individual patients remained unexplained.

As doctors extended the descriptive and explanatory reach of anatomical pathology, however, they began to press for specific, practical connections between their therapies and their pathology. They shifted the goals of medical therapy subtly to accommodate the progress of pathology. In the last decades of the century, the cooperation among pathological anatomy, anesthesia, and aseptic technique nurtured an expansive new field of surgical therapeutics.[2] Yet, outside the surgical amphitheater doctors continued to offer their patients medicines, treatments, and advice that often seem remarkably similar to those offered by their predecessors a century earlier. By the 1890s many physicians celebrated the great progress they had made in understanding disease, only to lament how far behind their ability to treat it had lagged. In reality, doctors had completely reworked their therapeutic goals by this time. Paradoxically, however, those efforts left many doctors with an ironic sense of the growing distance between their practice and their science.[3]

Reclassifying Disease

To understand this nineteenth-century paradox, we must first see how pathological anatomy directed attention to local, physical changes in the body and how it altered the categorization and definition of disease. Eighteenth-century physicians and their patients alike spoke of human illness as a form of disturbance in the balances within the body, and between the body and its surroundings. Although systemic disorders of bodily function had local manifestations and could settle in to afflict

by Christopher Crenner

specific parts of the body, such local manifestations of disease had to be understood in the context of an individual patient's overall constitution. To find Dr. William Cullen's eighteenth-century advice on treating disorders of the stomach, one had to refer to Part One in the first volume of his medical text, from 1799, which discussed "pyrexia or febrile diseases." Under Part One, Book II, on "inflammations or phlegmasiae," the concerned reader found in Chapter Eight the description of "gastritis or inflammation of the stomach," covering both "erythematic" and "phlegmatic" inflammations. Gastritis, for Cullen, existed primarily as a local manifestation of a general inflammatory condition of the body.[4]

Cullen concerned himself with a local affliction like gastritis insofar as it influenced the treatment of general bodily imbalances. In Chapter Eight he advised on the proper regimen of bloodletting and supportive nutrition to treat disorders that affected the stomach, but he offered no advice on specific, local treatment of the stomach. Inflammation of the stomach was significant for Cullen primarily because it influenced the proper treatment of the patient's general underlying disorder: "In some conditions of the body," he wrote, "in which this disease [erythematic inflammation of the stomach] arises, the Peruvian bark or bitters may seem to be indicated, but an erythematic state of the stomach does not commonly allow of them."[5] Cullen's principal therapeutic goal was to reestablish the balance in an individual's constitution that the illness had overturned. The specific features of what had gone awry in the patient's stomach were secondary to Cullen's eighteenth-century understanding of disease.

During the decades following Cullen, anatomical pathology shifted some of the doctor's focus from the patient's general constitution to the local lesion. Today, at the end of the twentieth century, physicians confidently view the connection between the physical details of local problems in the human body and the treatment of human disease as essential and direct. It is easy to cite examples from modern medicine in which a simple change in the details of pathological description has spurred dramatic change in the treatment of a disease.

In the treatment of gastric ulcers, for example, the recommended therapy has until recently been built around medicines that reduced the effects of acid on the stomach's lining. Since the 1980s, however, new information growing out of pathological observations has shifted attention away from treating acid's effects toward treating infections in the stomach. Investigations initiated by the Australian physician Barry J. Marshall and his colleagues have pointed to the presence of a specific microorganism, *Helicobacter pylori,* in ulcers.[6] Doctors are now increasingly advising the use of antibiotics in combination with acid-blocking medications to halt the destruction of the stomach lining. The direct connection that these doctors draw between the local physical features of ulcers and their rational treatment seems natural and productive. Such modern medical opinion rests on the strong connection between the goals of

medical therapy and pathological observation that evolved during the nineteenth century.

The change was slow and subtle—but profound when seen in the comparison of its end points. General medical texts offer a steady perspective from which to witness the gradual evolution. The gastric ulcer offers a similarly stable topic by which to measure the change. Ulcers were obvious local features of disease, and their identifying features were not generally disputed. During most of the nineteenth century, doctors writing about gastric ulcers in standard medical texts changed their views on neither the basic pathology nor the general therapy of the disorder. And yet the connections they drew between the two topics were radically different by the turn of the century. By looking at advice about therapy for ulcers in medical texts written and studied by nineteenth-century academic physicians, we catch a glimpse of a paradoxical discrepancy—the tightening links connecting pathology and treatment, and a growing pessimism about the contribution of new pathological knowledge to treatment.

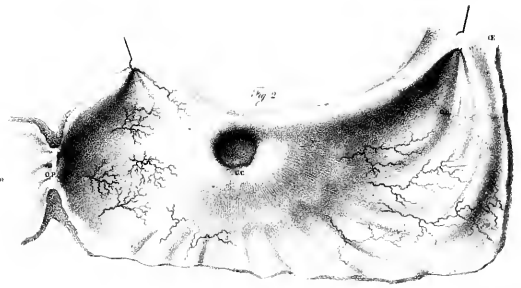
We should acknowledge that medical textbooks offer a privileged but narrow insight into the evolution of medical opinion. The limits of this perspective can be understood by returning to the modern example of treating gastric ulcers. Expert opinion today on the treatment of ulcers has indeed changed in response to new pathological knowledge. But do more people with ulcers actually get treated according to recommendation? We do not know. There is currently great interest in learning how, and if, doctors change their practices in response to changes in expert opinion.[7] Further, how many people with ulcers whose doctors give them prescriptions for antibiotics actually take them? Again, we do not know; and we have reason to be cautious about easy assumptions. The medicines that block acid production make people feel better, while the antibiotics for infections may exacerbate stomach pains. Changing medical advice does not necessarily signal any change in the behavior of doctors or patients.

The assumption of a direct correlation between advice in medical textbooks and actual practice in the nineteenth century is even more fraught with danger. Even if we limit our consideration to the rather exclusive group of medical practitioners who followed the standard academic medical literature of the times, the assumption of compliance with medical advice is not supported by the evidence.[8] Medical textbooks offer little help in reconstructing actual medical practices in the last century, but in these texts we can trace the organization and development of expert medical advice about pathology and treatment.

The first step in the realignment of therapeutic goals came early in the century, with the reclassification of diseases according to local pathological changes. Pathologists' explorations of local changes found in the body at death began to reshape categories of disease. A popular medical textbook of the 1840s, François Valleix's *Guide du Médicin Praticien*, included separate chapters on "gastritis" and "gastric ulcer."[9] The two conditions were, as

Valleix himself pointed out, difficult to distinguish in the living patient. But at autopsy they showed distinctly different local appearances. A person with pain in the region of the stomach, sensitivity to food, and vomiting could be suffering from gastritis or ulcer. The distinction between the diffuse inflammation of gastritis and the discrete "punched-out" holes of ulcers was dramatic at autopsy. The practitioner, Valleix insisted, had to attend carefully to clues like the progression of the disease or the recurrence of bleeding in order to distinguish gastritis from ulcer in the living patient.[10]

Such clinical observations were necessary to establish pathological categories. The mere recognition of the existence of ulceration in the stomach did not immediately establish ulcers as a separate category of disease. The American physician John Eberle, author of "a useful compendium of facts and principles in pathology and practice" in 1830, duly noted the existence of ulcers in the stomach but made no effort to separate them as a distinct form of disease.[11] He described two problems in the stomach: acute gastritis and chronic gastritis. In an acute case, Eberle noted, it was "common to have ulcerations and erosion," and similar lesions might be seen in chronic gastritis as well. Certainly, the practitioner looking for guidance in the care of people with painful stomachs would have an easier time in distinguishing chronic from acute problems than in divining the presence or absence of ulcers. Although demonstrably well educated in the "facts and principles of pathology," Eberle favored categories of disease like chronic and acute gastritis,



Dissection of the stomach of a twenty-nine-year-old carpenter who died in 1830 of a bleeding gastric ulcer. Five years earlier he had been successfully treated with astringents and two months of bed rest after an eight-day episode of hematemesis. He entered l'Hôpital de la Charité in Paris because of recurring hematemesis, fever, epigastric pain, and loss of appetite. At admission he was anemic and depressed, and his pulse was weak. Despite conventional treatment with leeches, plasters, a weak opiate, and a bland diet, he died eighteen days later.

At autopsy it was observed that he had bled from an artery in the center of a well-formed ulcer crater (marked "U.C."), directly into his stomach. The intestines were filled with reddish mucous that became increasingly blackened toward the colon. The esophagus is at the upper right, and the pylorus at the far left.

From J. Cruveilhier,* Anatomie Pathologique du Corps Humain, *4 vols. (Paris: J. B. Baillière, 1829–1835), vol. 1, installment 10, page 6, and plate 6, figure 2.

which were probably closer to the clinical syndromes that patients presented to him.

Yet pathological definitions like that of gastric ulcer rapidly accrued enough evidence about their characteristics in life to stand alone as new disease categories. By the 1840s and 1850s, ulcers had earned a place in general medical textbooks as a separate category of disease. Even Eberle in 1830 seemed to feel

some compulsion to follow the guidance of anatomical pathology more closely. In the preface to his text he stated that he had struggled to create an "arrangement founded on the particular structure primarily implicated in the disease," but that "correct and philosophical as such a classification may appear in theory . . . the attempt to reduce it to practice is attended with many very serious difficulties." Eberle found the pathological description of disease as a local disturbance in the structure of the body compelling. But he could not translate that system smoothly into practice. All the same, Eberle read clearly the signposts on the road ahead, adding that "should another edition of this treatise be called for, it is the intention of the author to arrange its materials upon this plan of classification."[12] As Valleix would point out a decade later, an ulcer might suddenly cause profuse bleeding or a uniformly fatal perforation into the abdomen. Gastritis did not.[13] Doctors began to experience the difficulty of knowing the anatomical lesions of their living patients as a significant ignorance—and perhaps a threatening one.

Traditional Therapy

Once doctors had conceived of a pathological category like the gastric ulcer as a separate disease, they confronted the question of its proper treatment. If it was suspected, how could it be treated to avert its attendant dangers? Pathological investigation had contributed no new substance or special technique to the physician's black bag. Physicians continued to rely on established methods to address the general constitutional imbalances that created local diseases like ulcers. In his textbook, Eberle offered a smooth presentation of the treatment of acute gastritis according to constitutional principles. Like Cullen before him, Eberle considered gastritis to be one of the many possible manifestations of a general inflammatory imbalance in the body. He asserted, as Cullen had, that an inflammatory condition required that "bleeding stands at the head of our remediate means." The doctor's first task in such cases was to reestablish balance in the overstimulated constitution through "prompt and copious depletion" of the sort that bloodletting offered. After the appropriate drainage of blood came "the application of leeches, followed by a large blister."[14]

The techniques Eberle recommended would rectify the general constitutional imbalance. But his therapies could also serve to minimize the discomforts accompanying the disorder: "After the general phlogistic condition of the system has been moderated by venesection [bloodletting], full doses of opium rarely fail to allay the pain and vomiting and to excite a general and salutary action of the cutaneous exhalants [e.g., the leeches and blisters on the skin]." Eberle portrayed a system of depletion and support intended to balance the human system and to ease discomfort. As an added benefit, a full dose of opium, Eberle noted, "tends to assist the action of the purgatives."[15] His therapeutics worked together to treat the general disorder and suffering of the patient.

Today we may have difficulty imagining how patients and doctors accepted a

system of therapeutics involving bloodletting, leeches, purgatives, and the like. But the doctor's focus on the individual characteristics of the patient turned the attention of patient and physician alike away from the specific mechanics of medical intervention. Patient and doctor focused instead on the changes that the interventions made in the workings of the patient's body—especially as those workings were experienced by the patient and appreciated and regulated by the doctor. Eberle and his colleagues early in the nineteenth century often relied on near-toxic doses of mercury and copious bloodletting. Those therapies were tolerable in part because patients shared with their doctors the conviction that mercury or bloodletting were simply means to an end. These therapies adjusted the natural functions of the body. The patient's experience of such adjustments was a central piece of the therapy.[16] Bloodletting could change the complexion or the pulse, for example, while mercury caused salivation and altered bowel habits.

Doctors did not apply mercury or bloodletting to every patient in the same way according to some rote formula. There was no ideal against which to measure the patient's constitution. Balance was an individual standard. After sizing up the patient's constitution and condition, the doctor applied a chosen technique until the predicted changes in the body's functions were achieved. Eberle advised physicians not to let blood to some predetermined amount but to take into account such features as the "smallness and frequency of the pulse."[17] Together with the doctor's careful advice about diet, personal habits, and environment, such medical interventions acted in a world equally accessible to doctor and patient alike.[18]

At the same time these medical treatments gave the doctor a means to intervene in the patient's direct experience of his or her body: to loosen the bowels, induce vomiting, or alter the pulse in a predicted manner. As alcohol, opium, or, later, strychnine joined mercury in the doctor's black bag, similar shared assumptions about the elements of health continued to underpin the therapeutic relationship between doctor and patient. Health depended on the proper balance of intake and outflow manifested by urine, phlegm, blood, stool, and saliva. Each patient's balances were unique to his or her own constitution and environment; when disease upset the balance, the doctor was expected to reestablish it by regulating input and output and the relationship to the environment.

Early in the nineteenth century, doctors largely avoided any tension between the generalized pathological view of disease and the more individualized view implied by traditional therapy. Physicians expressed the goals of their therapy and the justifications for their successes or failures in a language that had little to do with the features of local pathology. Thomas Watson, a British physician, for instance, gave a series of lectures at King's College in London that were reprinted for years starting in the 1840s. There was nothing compelling about the pathology of the ulcer to justify or explain the traditional therapeutic approach. Doctors could

understand therapies, said Watson, by studying case histories in the experience of individual doctors and patients. He asserted that the best evidence came from cases that had been successfully managed by well-known physicians. For instance, after summarizing in minute detail the various autopsy findings that characterized gastric ulcers, Watson turned to a story to illustrate his approach to the treatment of that problem. For the bulk of his discussion of therapy he relied on "a most striking and instructive case, beautifully told by the celebrated Doctor William Hunter."[19]

The lessons of Dr. Hunter's case derived as much from the overall manner and attitude of the celebrated doctor as from the specifics of his treatments. It was a matter of managing the patient and his surroundings as a whole. The case involved a young man brought in by his father with "great pain in the stomach, frequent and violent vomitings, great weakness and wasting of flesh." After carefully examining the child, Hunter took the father aside and confided to him that "no human sagacity or experience could pretend to ascertain the cause of his [the son's] complaint and . . . there is hardly anything to be aimed at in the way of the cure." The doctor then accompanied the father back to the bedside. There, with the hope that the patient "might be encouraged with hope and act his part with resolution," Hunter outlined a plan of treatment "with an air of being confident of success." His plan was "simple and perfectly understood." He advised only that the father "have his son well rubbed, for half an hour together with warm oil and a warm hand before a fire over and all around his stomach every morning and evening." For diet, the child must be limited to "milk . . . one spoonful. . . . If he vomits it after a little rest try him with a smaller quantity."[20] Following up on the forceful start, Hunter continued for another page on his detailed regulation of diet, activity, and of the relationship of father and son to their physician. The patient eventually recovered and went on to a healthy productive life. Watson concluded that valuable lessons were to be had from Hunter—although with regard to the choice of specific therapies for the ulcer Watson acknowledged that "the detail must be left to the common sense of the practitioner."[21]

New Pathological Definitions

While traditional therapeutics dwelt on the complex response of the individual to disease, pathological investigation continued to peel away the individual characteristics of the patient's afflictions, revealing deeper patterns of physical change in the body. Sometimes the evidence from autopsies unified a myriad of different afflictions under one specific pathological heading. Such was the fate of tuberculosis toward the close of the nineteenth century with the discovery of the organism we now call *Mycobacterium tuberculosis*. In his famous textbook *Principles and Practice of Medicine*, William Osler devoted seventy-two pages to the many manifestations of infectious tuberculosis in the human body. The characteristic pathological lesions of tuberculosis could appear in the lung, heart, bones, lymph nodes, kidney, or elsewhere; different

sorts of symptoms and afflictions accompanied the infection at each site. A wide range of seemingly separate problems thus came together in medical texts under the single heading of "tuberculosis."

In other cases, one seemingly unified disorder in life resolved on the autopsy table into a variety of unexpectedly distinct pathological conditions. Dropsy, a venerable term for abnormal accumulations of fluid of the body, came to be understood during the 1840s and 1850s as two different conditions defined in large part by different pathological changes. Sometimes dropsy was found to be associated with deterioration of the kidneys—a condition that became known as Bright's disease, its pathological changes carefully delineated by Richard Bright at Guy's Hospital in London.[22] At other times postmortem examinations showed dropsy was associated with pathological changes in the heart. Doctors found that what they and their patients had called dropsy was a cloak for a variety of deeper, distinctly different pathological changes.

Such grand transformations in the pathological understanding of disease steadily influenced thinking in therapeutics. Many doctors emphasized the failure of therapeutics to keep pace with the great changes in nineteenth-century pathological knowledge. But their dissatisfaction resulted from the influence of pathology as it gradually realigned therapeutic goals. The teachings of the autopsy table repeatedly reminded practitioners of the internal lesions created by disease. In the treatment of specific diseases, doctors attempted to make traditional treatments fit the new pathological understanding of disease. Returning to the example of the gastric ulcer, we can see how the growing importance of pathological thinking realigned the goals of treating ulcers.

New Therapeutic Goals

The well-known American physician Austin Flint composed a medical textbook in the 1870s in which he took a very optimistic view of the connections between therapeutics and pathological knowledge.[23] His recommended treatments for gastric ulcer, for example, would have been immediately recognizable to Thomas Watson or François Valleix and their colleagues thirty years earlier. But the consideration of what to use, when, and for what purposes, was more specifically guided by the increasingly pathological approach to medicine. In the intervening years a great deal more work had been invested in the pathology of gastric ulcers. Doubtless, Austin Flint developed his own approach to the difficult role of the physician in managing a patient's hope and confidence, or a parent's expectations. But he omitted such considerations from his discussions of therapeutics.

Flint organized and justified his therapies using evidence from pathology rather than details of individual patients and their circumstances. With regard to the proper diet for a patient with an ulcer, Flint, like Watson and Eberle before, recommended a combination of bland foods, including oatmeal, arrowroot, and milk. For Watson, dietary adjustment had been part of the general management of a patient's constitution.

Ulcers were manifestations of too much blood, excessive irritation, and high tone. Bland foods depleted and reset the patient's constitution in the same way that purges and bloodletting did. By contrast, Flint explained his choice of diet by referring to the particular local pathology of the ulcer. He suggested that "the articles which, combined out of the body, would make a soothing poultice for an ulcer of the skin, are the most likely to be tolerated by the stomach."[24]

To Flint's mind, dietary change was effective therapy because of its direct physical effect on the pathological lesion, the ulcer. Since pathology had brought to light the hidden, internal problem of gastric ulcer, Flint could think of an ulcer as though it were analogous to the familiar lesions on the skin.

The development of pathological anatomy not only made apparent the specific internal lesions of a disease, it also created new dynamic ways of understanding disease. As pathologists continued to probe into the nature of lesions like ulcers, they began to speculate on the local, physical causes of those lesions. The pathology of a gastric ulcer, for example, became no longer simply the visible lesion in the stomach. Instead, the ulcer could be described in terms of the series of changes, sometimes microscopic, that created the typical lesion.

Austin Flint followed these new trends in pathology. He filled out the discussion of ulcers in his textbook by citing the influential German pathologist Rudolph Virchow, who had speculated on the pathological development of ulcers. Virchow proposed that he could see the origins of stomach ulcers at autopsy in the microscopic obstructions in the blood vessels feeding the wall of the stomach. Flint himself remained uncommitted, stating that "the pathological character of the gastric ulcer is not fully settled."[25] Still, the pathological description of an ulcer as a disturbance in the stomach's structure, with a specific origin and fate, directly guided Flint's chapter on the treatment of ulcers.

Flint used a pathological understanding of ulcers to set a new goal for his therapies, very different from the goals implied in the treatments of Eberle, Valleix, or Watson. Flint opened his discussion of ulcer therapy with the observation that ulcers were "by no means incurable . . . based upon the number of instances of cicatrized [scarred] ulcers found in autopsy examinations."[26]

Pathological observations suggested that an ulcer had a specific course of development. It might grow and take a pernicious course to perforate, or bleed. Or it might scar over and heal. Although Flint was not convinced that he understood the ultimate origin of ulcers, he knew the possible paths along which they developed. He characterized the goal of treatment as guiding ulcers along one pathologically defined course, cicatrization, rather than another more damaging course. By thus defining the task of treatment, Flint had to acknowledge the shortcomings of available therapies. "It is doubtful," he confessed, "whether any remedies exert a direct effect to promote cicatrization." But he went on to justify traditional remedies—including a bland diet and opium—in terms related to the pathological course

of ulcers: "[C]icatrization is promoted indirectly by remedies which arrest the peristaltic movements of the stomach . . . [and in this regard] opium in some form is the most effective remedy."[27] But Flint's approach to the justification of specific therapies demonstrated his still-novel conviction that the treatment of specific pathological lesions could be a feasible goal of medical therapy.

Still, Flint had very little new to add to his armamentarium of medications. And the goal he espoused for his therapies—that they make a physical difference in the pathological lesions—highlighted the shortcomings of traditional therapeutics and minimized its powers. By the end of the century, many physicians were voicing pessimism about the contributions of the medical sciences to contemporary therapies.

Medical textbooks and articles tolerated an increasingly skeptical view toward medical therapeutics as the nineteenth century progressed.[28] The American physician Oliver Wendell Holmes became famous at midcentury for his pronouncements on the evils of the contemporary pharmacopeia. He cheerfully advocated sinking the entire lot of draughts, drops, medicinals, and concoctions to the bottom of the ocean—or at least discounting a patient's bill an appropriate amount for each dose swallowed. By the turn of the century, a scholar of medical science, the physician S. Weir Mitchell, lamented that the most obvious lesson to be drawn from the century's medical progress was "therapeutic nihilism"—a skeptical approach to all contemporary therapies. Could pathology's only gift to medical practice be to support the case against any practice at all? The extensive work in medical pathology and related sciences in the nineteenth century seemed to some doctors only to bring them directly up against the profound limitations of their craft.

Therapeutic Irony

Austin Flint's change in approach to the treatment of ulcers was quite different from our example about treating ulcers in the 1990s. Flint did not offer any radical new treatment for ulcers based on information about their fundamental nature—as do the doctors who advise using antibiotics for ulcers today. Flint offered only a reinterpretation of the possible uses of existing therapies. As pathology and the host of associated medical sciences continued to gain momentum during the nineteenth century, the shortcomings of simply realigning the goals of traditional therapeutic methods became more evident. The revelation of new localizable, physical evidence of disease offered a clear direction for progress in therapeutics. For example, the ability to isolate disease-causing microorganisms in the laboratory and to develop vaccines and inocula against them offered a promising road ahead at the turn of the century. But all this progress left practicing physicians in an equally awkward position. They seemed to be learning more and more about problems that they were correspondingly more ignorant about how to change.

Part of the redemption of therapeutics came through the remarkable transformation of surgery in the latter part of the

century. What better cure for the specific pathological lesion than to cut it out? And this approach surely sustained the increasing focus on local pathology. But doctors outside the surgical amphitheater needed new schemes for explaining to themselves what it was that they did day to day when treating their patients.

Late-nineteenth-century physicians had to learn to relish the irony of their problem as they rethought the goals of medical therapeutics. Humility had long supported the physician's understanding of the limitations of his craft. In the anecdote about Hunter, the celebrated doctor had offered a profound humility about the limitations of medicine in response to a father's fears and anxieties. The growth of pathological knowledge and the realignment of therapeutic goals still left room for humility, but created too a new place in the physician's repertoire for irony. Irony about the limitations of therapy became a great tool within the profession for explaining the work of the doctor.

At the close of the nineteenth century, William Osler became one of the best-known teachers of the new approach. He helped disseminate throughout the medical community a coherent explanation of what medicine could accomplish. Understand the physical roots of disease exactly, said Osler, treat the disease's symptoms compassionately, and hope that we can come up with something better.

Part of the irony lay in Osler's insistence on the primary role that the doctor had in treating the symptoms of disease. Symptoms came to be understood for the most part as secondary to the primary processes of diseases as revealed by pathology. And yet the treatment of symptoms was what the physician did best. Here is the disease, Osler would state under the section on pathology in his medical textbook explaining in exhausting detail the anatomical and microscopic characteristics of the condition's lesions. And here, he would state in the section on treatment, is how we manage the symptoms. Osler opened the section on ulcers with the warning that "medicinal measures are of very little value in gastric ulcer." But he continued for another page listing the standard medicines employed with the explanation that they "do not probably benefit the ulcer," although they might make the patient feel better.[29]

Throughout his text, Osler repeated and developed the device of introducing his discussion of treatment by means of a disclaimer: though we may understand exactly, we do not treat what we understand. After chronicling the many complex clinical and pathological manifestations of tuberculosis, Osler introduced his section on the "general medical treatment" of tuberculosis with the observation that "[n]o medicinal agents have any special or peculiar action upon tuberculous processes."[30] His advice on the treatment of tuberculosis fell into two familiar old sections. First came advice on diet, activity, and environment: nutritious foods, ample rest, and fresh air. Second, Osler offered the late-nineteenth-century version of the regulation of the body's functions: the treatment of specific symptoms. Osler grouped his medical therapies for tuberculosis under the headings of treatment

for fever, cough, sweating, diarrhea, hemoptysis, pleuritic pains, and dyspepsia. One hundred years before, doctors had offered medicines to regulate the bowels, the complexion, the discharges, and the like. At the end of the century, many of the same substances were still being given, sometimes with the aim of exactly the same results in the patient. Osler still listed mercury for the treatment of tuberculous dyspepsia. The goal remained in many cases to create perceptible changes in the body's functions: to alter diarrhea, cough, or sweating. But at the beginning of the century, the alterations of bodily function constituted the core reality of disease. For Osler and his colleagues, these alterations were only symptoms of what seemed to be much more certainly a deeper pathology, a pathology untouched by their therapies.

As the nineteenth century opened, physicians began to organize their thinking about disease in ways increasingly defined by the lesions observed in the pathological laboratory. Medical therapy—with its emphasis on the context of the patient's illness, the balance of internal and external fluxes, and the relationship of the patient to the weather, to daily habit, to diet, and to the physician—took little guidance at first from the pathological reclassifications. But both the allure of pathological explanations of disease and the ability of pathology to draw more and more of the details of individual illness into its explanatory systems nourished attempts to realign the goals of medical therapy according to pathological observation. Traditional therapeutic methods, however, had limited potential to change the fundamental physical features of disease. Osler and other physicians gradually developed a new and sometimes ironically charged understanding of what it meant to change the way an individual experienced and responded to internal and external environments. Most of the patient's illness became a side effect of the underlying physical disease. The doctor might understand the disease in pathological terms all too well but could only intervene to alter the symptoms, the side effects, of a particular disease.

Physicians could remain confident of their expanding knowledge of the physical details of disease. And they could remain confident of their ability to moderate many of the effects of the disease on their patients. But they had to learn to appreciate the irony of the growing distance between what they began to distinguish as the science and the art of medicine—the ability to understand the disease and the ability to treat the patient.

The most recent edition of the widely used general medical text *Harrison's Principles of Internal Medicine* concludes its brief discussion of diet in the treatment of duodenal ulcers with the contention that there is no evidence for any specific effect of diet on ulcers at all. Nonetheless, the author grants the modern doctor special dispensation to respond to the common impression that diet is important: "It is reasonable to suggest that if patients experience symptoms after ingestion of certain foods, these foods should be avoided."[31] A late-

nineteenth-century physician would have appreciated the irony of that position perhaps better than we do today.

Notes

1. For the transformation of medicine around pathology at the beginning of the nineteenth century, compare Michel Foucault, *The Birth of the Clinic: An Archeology of Medical Perception*, trans. A. M. Sheridan Smith (New York: Vintage Books, 1973), and Erwin H. Ackerknecht, *Medicine at the Paris Hospital, 1794–1848* (Baltimore: Johns Hopkins University Press, 1967). The quotation by Bichat is cited in Foucault, *Birth of the Clinic*, 146.

2. For developments in succeeding decades, see, for example, James R. Wright, "The Development of the Frozen Section Technique, the Evolution of Surgical Biopsy and the Origins of Surgical Pathology," *Bulletin of the History of Medicine* 59 (1985): 292–326.

3. For a careful examination of the general significance of science to medicine during the nineteenth century, see John Harley Warner, "Science in Medicine," in *Historical Writing on American Science: Perspectives and Prospects*, ed. Sally Gregory Kohlstedt and Margaret W. Rossiter (Baltimore: Johns Hopkins University Press, 1986), 37–58; and Warner, "Ideals of Science and Their Discontents in Late Nineteenth-Century American Medicine," *Isis* 82 (1991): 454–78.

4. William Cullen, *First Lines of the Practice of Physic*, 4 vols. (Edinburgh: C. Elliot, 1799), 1:iv. Cullen also included as a cause of gastritis external irritants that could be treated by identification and removal of the irritant.

5. Ibid., 427.

6. B. J. Marshall and J. R. Warren, "Unidentified Curved Bacilli in the Stomach of Patients with Gastritis and Peptic Ulceration," *Lancet* 8390 (June 16, 1984): 1:1311–14; J. R. Warren and B. J. Marshall, "Unidentified Curved Bacilli on Gastric Epithelium in Active Chronic Gastritis," letter, *Lancet* 8336 (June 4 , 1983): 1:1273–75.

7. See, for example, A. Gray Ellrodt et al., "Measuring and Improving Physician Compliance with Clinical Practice Guidelines: A Controlled Interventional Trial," *Annals of Internal Medicine* 122 (1995): 277–82.

8. John Harley Warner, *The Therapeutic Perspective: Medical Practice, Knowledge, and Identity in America, 1820–1885* (Cambridge, Mass.: Harvard University Press, 1986).

9. François Louis Isidore Valleix, *Guide du Medécin Praticien, ou Résumé Général de Pathologie Interne et de Therapeutique Appliquées*, 10 vols. (Paris: J. B. Baillière, 1842–1847); a fifth edition appeared in 1866, revised by P. Lorain (Paris: J. B. Baillière, 1866).

10. Valleix, *Guide du Medécin Praticien*, 171–72.

11. John Eberle, *A Treatise on the Practice of Medicine*, 2 vols. (Philadelphia: John Grigg, 1830), 1:vi.

12. Ibid., vi–vii.

13. Valleix, *Guide du Medécin Praticien*, 171.

14. Eberle, *Treatise on the Practice of Medicine*, 1:188.

15. Ibid., 187–88.

16. Compare, for example, a patient's experience of modern chemotherapeutic regimens, in which the belief is that these

agents imperceptibly kill off cancer cells while the patient's powerful, direct experience of the therapy falls into the category of a side effect.

17. Eberle, *Treatise on the Practice of Medicine,* 1:187.

18. Charles E. Rosenberg, "The Therapeutic Revolution: Medicine, Meaning, and Social Change in Nineteenth-Century America," in *The Therapeutic Revolution: Essays in the Social History of American Medicine,* ed. Morris J. Vogel and Charles E. Rosenberg (Philadelphia: University of Pennsylvania Press, 1979), 3–25; Warner, *The Therapeutic Perspective.*

19. Thomas Watson, *Lectures on the Principles and Practice of Physic Delivered at King's College, London,* rev. 2d Am. ed. from the 2d ed. (Philadelphia: Lea and Blanchard, 1845), 773.

20. Watson, *Lectures,* 4th ed. (London: John W. Parker, 1857), 2:438.

21. Ibid., 436.

22. See, including the editor's introduction, Steven J. Peitzman, "From Bright's Disease to End-Stage Renal Disease," in *Framing Disease: Studies in Cultural History,* ed. Charles E. Rosenberg and Janet Golden (New Brunswick: Rutgers University Press, 1992), 3–19.

23. Austin Flint, *A Treatise on the Principles and Practice of Medicine* (Philadelphia: Henry C. Lea, 1873).

24. Ibid., 409.

25. Ibid., 406.

26. Ibid., 409.

27. Ibid., 410.

28. Rosenberg, "Therapeutic Revolution," 20–22.

29. Sir William Osler, *The Principles and Practice of Medicine: Designed for the Use of Practitioners and Students of Medicine* (New York: D. Appleton, 1892), 375.

30. Ibid., 253.

31. James E. McGuigan, "Peptic Ulcer and Gastritis," in *Harrison's Principles of Internal Medicine,* ed. K. J. Isselbacher, E. Braunwald, et al., 2 vols. (New York: McGraw-Hill Inc., 1994), 2:1371.

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